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Procedure for the Evaluation of Environmental Monitoring Laboratories

Tracor Jitco, Inc, Rockville, Md

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Procedure for the Evaluation of Environmental Monitoring Laboratories

Environmental Monitoring Series

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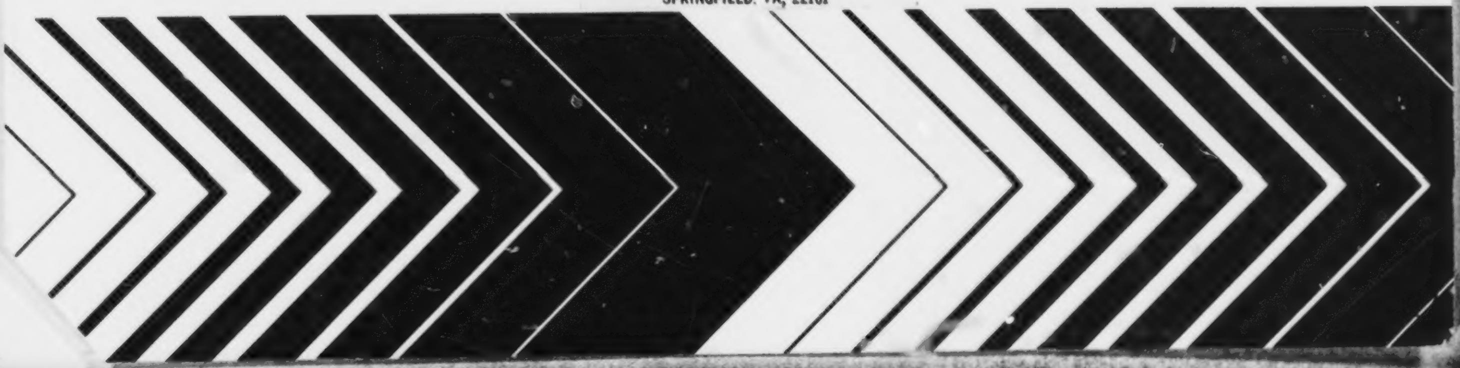

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A procedure was developed for the on-site evaluation of environmental laboratories in such media as air, water, radiation and pesticides. The procedure includes registration and preliminary questionnaire forms, on-site visits checklist, evaluator's guide and a scoring system for assessment of the laboratory's management, personnel, facilities, analytical methodology and instruments and its quality control procedures.

This research report is not an official EPA manual. Rather, it is a report which is but one of a series being used as input to develop *EPA Manuals and Guidelines for Certification Programs.*

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PROCEDURE FOR THE EVALUATION OF ENVIRONMENTAL MONITORING LABORATORIES

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CINCINNATI, OHIO 45268

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This report has been reviewed by the Environmental Monitoring and Support Laboratory-Cincinnati, U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

FOREWORD

Environmental measurements are required to determine the quality of ambient waters and the character of waste effluents. The Environmental Monitoring and Support Laboratory-Cincinnati conducts research to:

- Develop and evaluate techniques to measure the presence and concentration of physical, chemical and radiological pollutants in water, wastewater, bottom sediments and solid waste.

- Investigate methods for the concentration, recovery and identification of viruses, bacteria and other microbiological organisms in water. Conduct studies to determine the responses of aquatic organisms to water quality.

- Conduct an Agency-wide quality assurance program to assure standardization and quality control of systems for monitoring water and wastewater.

The latest quality assurance report on procedures for evaluation of environmental monitoring laboratories was prepared by Tracor Jitco, Inc. The report, in detail, contains registration and preliminary questionnaire forms, on-site visit checklist, evaluator's guide, and a scoring system for assessment of the laboratory's management, personnel, facilities, analytical methodology and instruments, and its quality control procedures.

This research report is not an official EPA Manual. Rather, it is a report which is but one of a series being used as input to develop *EPA Manuals and Guidelines for Certification Programs.*

Dwight G. Ballinger
Director, EMSL-Cincinnati

ABSTRACT

Tracor Jitco, Inc., examined in depth existing evaluation procedures of EPA, Federal and State Agencies with the aim of incorporating their best features in a procedure for general use in evaluating laboratories engaged in measuring environmental pollution.

The procedures developed are suitable for the media of air, water, radiation, and pesticides. They are intended for use by EPA Regions in evaluating state laboratories and by the states in evaluating local or private laboratories. They are useful as a management tool to control or upgrade laboratory performance or they could be used as part of a laboratory accreditation or certification system. The inclusion of a scoring plan makes it possible, with suitable training of evaluators in uniform application of the procedures, to make comparisons with standards of performance.

The laboratories are required to provide information on physical plant, equipment, personnel, quality control and other general aspects of laboratory performance on check-off types of forms provided. This is followed by an on-site inspection during which information on less quantifiable aspects are obtained. This phase of the evaluation is oriented to the specific methodology for which the laboratory is to be qualified.

The scoring system includes inherent weighing of criteria. The procedure is designed to be compatible with programs of proficiency testing and taken as a part of a total quality assurance program will contribute to the objectivity of the determination of laboratory capability.

This research report is not an official EPA manual. Rather, it is a report which is but one of a series being used as input to develop *EPA Manuals and Guidelines for Certification Programs*.

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Thanks are due to the Project Officer, Mr. Edward Berg, and to the staff of the Environmental Monitoring and Support Laboratory, Cincinnati, for their support of this project. The many EPA Research Laboratories and Regional Laboratories visited at various stages of development of the procedure were all most generous in providing information and in giving advise. We also found very helpful the review of the draft of the procedure by the Wisconsin Department of Natural Resources and the Illinois Environmental Protection Agency. We encountered many points of view and have done our best to reconcile differences and to come up with a procedure that is standardized, widely useful, and fair in its application.

SECTION 1
INTRODUCTION

An evaluation procedure has been developed based on EPA experience in evaluating its Regional Laboratories, the experience of other governmental and private evaluating agencies, and the combined experience of the contractor's senior staff.

Nevertheless, the result has been arrived at independently, specifically without reference to EPA's conclusions about its own evaluation efforts. This was done consciously so that the result of the contractor's efforts will stand on its own merits. Moreover, it has the advantage that a completely disinterested point of view has been brought to bear on the problem.

Two objectives of the project have had a strong bearing on the nature of the procedure that has been developed:

1. A major objective was to produce combined forms containing sections with general application and sections with applications to specific media, in recognition of the fact that the areas of uniformity in an evaluation protocol outweigh the differences required by the media covered, namely air, water, radiation, and pesticides.

2. A plan of scoring was required, using rating criteria based on standards of acceptability in operation in EPA and elsewhere and based on the contractor's own experienced judgment.

The resulting procedure has several unique aspects.

- It collects information about areas of management, personnel, facilities, methodology, instrumentation, and quality control oriented toward the requirements of environmental monitoring laboratories.

- It presents criteria against which the individual laboratory may be judged in each area.

- It contains an Evaluator's Guide which explains the intent of inspection in each area and suggests specific questions to be asked to enable the evaluator to arrive at the necessary judgments.

- It is sectionalized as to methodology and equipment so that only the parts applicable to even a small laboratory or to a laboratory devoted to a single medium need be used, thus avoiding unnecessary burden on the laboratory.

- The scoring system is adjustable to the size and scope of the laboratory yet provides a final score which is comparable under any circumstances of use of the procedure.

SECTION 2
CONCLUSIONS

The procedure which has been presented in this manual is directly applicable to the evaluation of laboratories of all sizes. In its entirety it will apply to large laboratories. In this application it is lengthy, but its length is justified by the necessity for a thorough inspection of all aspects of laboratory personnel, facilities, equipment, and operations. To do less would be to slight some important aspect and make difficult a balanced, meaningful scoring system.

For smaller laboratories or specialized laboratories, only the applicable portions of the procedure need to be used. The Registration Form is intended to provide information that will make it necessary to send out only the pertinent parts of the Preliminary Questionnaire. The information provided by the Preliminary Questionnaire, assimilated by the evaluator, or evaluation team, before the onsite visit should limit the first hand inspection to the aspects of the laboratory's operations that appear to deviate from standard.

When used conscientiously by evaluators with pertinent scientific background the procedure and its scoring system should result in the ability to discern those laboratories that are acceptable participants in the environmental monitoring programs.

SECTION 3
BACKGROUND AND SCOPE

The pollution of the atmosphere, the contamination of the waters, and the littering of the land have become problems international in scope. The continued violence done by man to the total environment must be checked if this planet is to remain a fit place in which to live. One of the first steps that can be taken is the qualitative and quantitative monitoring of the environment.

Successful monitoring of the environment requires the identification of the contaminants, an accurate measurement of the amounts present, and pin-pointing of the sources of the pollution. Because of the increase in number of contaminating substances, many of which require sophisticated analysis, and because of the reduction in levels of pollution that can be tolerated, the involvement of an increasingly large number of people and of laboratories is required.

In the United States, the U.S. Environmental Protection Agency has the responsibility for enforcement of national laws and regulations designed to restore and protect the environment. Its work is assisted and supplemented by environmental programs carried out by the states. The private sector is also depended upon to carry a part of the laboratory analytical workload. The wide diffusion of monitoring and analysis leads to a need for standards of performance. Extensive laboratory inspection and evaluation must be done to ascertain the capabilities of the participating laboratories. In order to avoid arbitrary inspections and to protect both the evaluating agency and the laboratories from capricious judgements, this procedure which standardizes requirements has been prepared.

The procedure provides a basis for inspection and evaluation of environmental monitoring laboratories at national, state, and private levels. It is applicable to laboratories concerned with the various media, particularly air, water, pesticides, and radiation. The experience of EPA and of other standardizing institutions has been used as a basis for this procedure. It is thorough, yet as concise as the intended wide range of applicability permits.

This procedure employs standards which will make evaluation as objective as it can be made. It includes a scoring system for assessment of the laboratory's management, personnel, facilities, analytical methodology and instruments, and its quality control procedures. An acceptable score will signify that there are no serious deficiencies in the organization, physical plant, or technical operations of the laboratory.

PURPOSE OF EVALUATION

Enhancement of the performance of environmental monitoring laboratories is the primary goal of the laboratory evaluation. Its purpose is to ascertain that the laboratory follows sound scientific procedures in its analytical work; that it operates under the auspices of good management and professional supervisors; that it utilizes proper equipment; and that it maintains and uses accurate records. The evaluation procedure provides the laboratory an opportunity for improvement by identifying weaknesses in its organization or performance and to obtain information and assistance for overall improvement. In this sense, the evaluation may serve not only to assure laboratory competence; but also to promote professionalism in the laboratory by facilitating the establishment of standards of excellence.

Any system designed for the evaluation of laboratories will inevitably identify certain laboratories which fail to meet the established standards. This procedure for evaluation of laboratories does not necessitate a definitive rejection of unqualified laboratories. It provides an opportunity for the laboratory to correct existing deficiencies. If the laboratory complies with recommended modifications, it may receive an acceptable rating.

The uniform scoring system employed in the procedure considers a large number of characteristics which are given preassigned weights. This contributes to the objectiveness and comparability of the evaluation which are among its principal purposes.

INTENDED APPLICATIONS OF THE PROCEDURE

The procedure for laboratory evaluation is a versatile instrument. The preliminary questionnaire coupled with the onsite checklists is suitable to a number of situations. It may serve as a self-evaluation for Environmental Protection Agency laboratories. It may be used by EPA for the evaluation of state laboratories. It could be used by state laboratory personnel to evaluate commercial laboratories. The procedure was not designed for use in a formal certification program, however, it could readily be adapted for that purpose.

Although it is recognized that the different media of air, water, pesticides, and radiation have some unique methodologies, the areas of uniformity in all laboratories outweigh the differences and a generally applicable procedure has been developed. Sections with application to specific media can be used for inspection to the extent necessary.

The procedure does not purport to be a panacea. For example, although recognition is given to the necessity for participation in inter-laboratory proficiency testing programs, the scores obtained in such programs do not enter directly into the scoring recommended in this procedure. The procedure simply provides a methodology necessary for environmentally concerned scientists to ensure that a laboratory has the capability for valid analyses. The combination of the score from applying this procedure with scores from inter-laboratory testing programs should be the object of further consideration.

The extremely large number of data points collected may have to be collated by computer. Although this is not one of the requirements of this procedure, most of the data will have been recorded in such a way that it can readily be computerized. Most of the answers to the questionnaire require only a checkmark and not involved descriptions of the laboratory.

The media covered include the broad application of environmental monitoring to air, water, pesticides, and radiation. This involves chemical methodology appropriate to potable water, wastewater, ambient water, ambient air, stack emissions and other source emissions into the atmosphere, sediments, pesticides and other organic chemicals, both natural and industrial. It involves biology, including aquatic biology and virology. It also includes bacteriology as applied to potable water, waste water and ambient water. Finally, it includes radiation measurement.

The analytical methodology required is in a state of flux. Some methods are EPA approved, some are used as interim methods and others are in various states of development and are in more or less wide use. Although this procedure lends itself to the evaluation of performance of all methodology required in the various areas, the material actually presented on methodology is limited to those methods referenced in the Federal Register. These are the presently EPA approved methods. For water and radiation test methods, see Federal Register, Vol. 35, No. 199, October 16, 1973. Interim methods for algicides, chlorinated organic compounds, and pesticides can be obtained from the Environmental Monitoring and Support Laboratory, USEPA, 1014 Broadway, Cincinnati, Ohio 45268. Air test methods are referenced in Federal Register, Vol. 36, No. 228, November 25, 1971 and Vol. 38, No. 110, June 8, 1973.

Methods for measurement of emissions from stationary sources differ in important aspects from methods for measurement in ambient air. These source methods are to be found in Federal Register, Vol. 36, No. 247, Part II, December 1971; Vol. 38, No. 111, June 11, 1973; Vol. 39, No. 47, March 8, 1974; Vol. 40, No. 152, August 6, 1975; and Vol. 40, No. 194, October 6, 1975.

Biology is an important area not covered by referenced methods. However, see Bibliography items 6-7-8-9 for methods in use that may be consulted for methodological requirements of satisfactory laboratory performance in this area.

Modified or alternate methods ("equivalent" methods) may be used if specifically approved under published regulations. A laboratory under evaluation is required to provide information on any such methods in use. The evaluator must refer to this information in order to judge whether the laboratory's use of the methods produces satisfactory results.

Although some state environmental monitoring laboratories are a part of, or are closely associated with, Health Laboratories, this procedure is not intended for use in any health oriented analyses. Procedures exist for evaluation of health laboratories where this is required for certification or licensing.

Although the word "laboratory" is used, it is emphasized that the field aspects as well as the laboratory aspects of environmental monitoring must be a part of any complete evaluation. The procedure developed herein is compatible with the "total system" concept. The evaluator should go into the field to look at monitoring equipment including flow measurement instrumentation and automatic sample compositing equipment.

USE OF PROCEDURE

Experts, such as those found in the larger environmental protection agencies, who are experienced in all of the media may not always be available for inspection and evaluation duties. It may be necessary to employ evaluators who have not had long years of experience in all the details of methodology of environmental monitoring. Therefore, this procedure has been designed for use by individuals who are skilled in science, but who will find guidelines useful for the evaluation of specialized laboratories. An elaborate "Guide for Evaluators" is an essential part of the Manual.

As a part of this "Guide" there is included, where available, very detailed background material in some of the specialized methodologies. For example, the EPA Check List for Bacteriological Examination of Water is to be found in Part 4. Also, recommended laboratory performance standards are included, such as "A Schedule of Suggested Instrument Calibrations" and a "Table of Recommendations for Sampling and Sample Preservation" from the EPA Manual of Methods for Chemical Analysis of Water and Wastes. Other such helps could be added, if so desired, as they became available.

The ideal evaluator should possess a broad understanding of scientific methods and an appreciation of the complexity of analytic procedures. A strong background in an applied science, preferably chemistry, coupled with some experience in laboratory management should equip the inspector with the insight required to thoroughly assess a laboratory's operation.

The qualifications required for the position of evaluator should be strictly observed. Failure to do so would be a disservice to both the EPA and the laboratory undergoing evaluation. For even the most detailed and efficient guidelines cannot guarantee a quality evaluation if administered by an unqualified individual.

The evaluation procedure, though not extremely complex, is lengthy and time-consuming. It will run most smoothly if the evaluators have had some training in its use. The introductory material, the various instruction sheets, and particularly the "Evaluator's Guide" may be used as a text in training sessions for evaluators. If such training sessions are not arranged, at least the evaluator should study the entire procedure thoroughly before embarking on an evaluation.

SECTION 4
REGISTRATION AND PRELIMINARY EVALUATION

The U.S. Environmental Protection Agency is engaged in the monumental task of pollution abatement and control on a national scale. The workload grows with the increase of substances which require sophisticated analyses, with the growing technical complexity of analytical procedures and with the reduction of tolerated contamination levels. The cooperation of many laboratories, state and commercial, must be enlisted to further EPA's efforts to maintain the integrity of the environment.

Laboratories which participate in environmental monitoring must meet rigid standards of excellence. The data gleaned from their analyses must be defendable for it may serve as evidence in a court of law. To ensure the analytic capabilities of collaboratoring laboratories, EPA has instituted a systematic evaluation procedure.

The evaluation procedure is a standardized instrument designed to produce an objective appraisal of a laboratory's performance. It strives to utilize the insights of a qualified evaluator without falling prey to the caprices of a subjective appraisal. It employs a numerical scoring system to organize the myriad details and to produce a manageable result. The scoring framework supplies a strong influence toward uniformity in the application of criteria from laboratory to laboratory.

A laboratory evaluation is a time consuming endeavor. To minimize this time factor, the EPA procedure consists of a three step process: Registration, Completion of a Preliminary Questionnaire by the laboratory, and an Onsite survey by personnel of the evaluating agency.

A laboratory interested in participating in an evaluation may identify itself by completion of a brief registration form. This form will indicate to the evaluating agency the extent of the evaluation required, i.e., whether it is to cover all media or a few tests for one medium.

Parts 1, 2, 3, and 6 will go to all laboratories. Those parts of Part 4 (Chart C - Analytical Methodology) and of Part 5 (Chart D - Analytical Instruments) applicable to the media with which the laboratory is involved will be selected and sent to the laboratory for completion.

Return of the completed questionnaire triggers the final phase of the evaluation.

The evaluator carefully studies the information provided by the laboratory and notes any items which require special attention. The onsite visit is then scheduled.

During the onsite visit, the evaluator implements the numerical scoring system to assess the laboratory operation. Any deficiencies which require improvement prior to scoring are identified and discussed with the laboratory.

When the evaluation has been completed, a written report of deficiencies and recommendations will be sent to the laboratory director. Upon return of satisfactory evidence that all reported deficiencies have been taken care of, a final score will be issued.

An acceptable score will signify that the laboratory is fully qualified to participate in the vital work of preserving a safe, liveable environment.

REGISTRATION FORM

The evaluation of Environmental Monitoring Laboratories is designed to assist the participating laboratories to upgrade their overall performance in order to safeguard the scientific and legal validity of their data. Submission of this registration form is the first step in the evaluation process. A preliminary questionnaire which requests background information about the laboratory's staff, facilities, and operating procedures is the second step. Upon completion of the preliminary questionnaire, an onsite visit to assess the performance capability of the laboratory will be scheduled at the convenience of the laboratory.

1. Name of Laboratory ____________________
2. Address ____________________
3. Telephone Number ____________________
4. Name of Laboratory Director ____________________
5. If Private, Name of Owner ____________________
6. Type of Laboratory ____________________
   - ☐ Commercial (privately owned, works on fee or contract basis)
   - ☐ Noncommercial (publicly controlled; usually does not work on a fee basis)
7. Provide a brief functional description of the activities of the laboratory ____________________

   ____

   ____

8. Media to be covered in evaluation
   - ☐ Water
     - ☐ Chemistry
     - ☐ Bacteriology
     - ☐ Biology
   - ☐ Air
   - ☐ Pesticides
   - ☐ Radiation
   - ☐ Other (specify) ____________________
9. If evaluation is not desired for complete analysis of any one of the media, list the specific tests for which you wish to be evaluated. An index of tests for which EPA approved methods are availiable is given on overleaf.* (Do not list for any medium for which you desire complete evaluation.)

   ____________ ____________ ____________

   ____________ ____________ ____________

   ____________ ____________ ____________

   ____________ ____________ ____________

10. Total Number of employees ________ Technical ________ Administrative ________

* EPA approved water and radiation test methods are referenced in Federal Register, Vol. 35, No. 199, October 16, 1973 Interim methods for algicides, chlorinated organic compounds, and pesticides can be obtained from Environmental Monitoring and Support Laboratory, U. S. Environmental Protection Agency, 1014 Broadway, Cincinnati, Ohio 45268. EPA approved air test methods are referenced in Federal Register, Vol. 36, No. 228, November 25, 1971, and Vol. 38, No. 110, June 8, 1973.

Signature of Director ____________________ Date ____________

PRELIMINARY QUESTIONNAIRE

This questionnaire is designed to elicit all the information required prior to an onsite survey. Please make a concerted effort to furnish the information as accurately and concisely as possible.

For convenience, the questionnaire has been divided into six parts:

1) General Laboratory Information

2) Personnel

3) Laboratory Space and Facilities

4) Technical Services

5) Analytical Instruments and Special Apparatus

6) Quality Control

In each section, the questions are styled for the ease of the laboratory's response. In many cases only a check (✓) is required. Other questions call for a short answer; clarity and brevity should hallmark your response. If you need more space, please continue on blank sheets and attach them to the questionnaire.

Each section is independent, so that the different sections may be distributed to the most knowledgeable persons in the laboratory who can complete their parts independently. Finally, management can assemble and check all responses before returning the completed forms.

Upon return of the completed questionnaire, the onsite visit will be scheduled at your convenience. The time involved in the onsite evaluation can be minimized by a thorough presentation of the information sought in the preliminary questionnaire. Therefore, it is advantageous to both your laboratory and the evaluating agency if these questions are answered precisely and completely.

Thank you for your cooperation.

PART 1. GENERAL INFORMATION ABOUT THE LABORATORY

1. Name of Laboratory ______________________________

2. Address ______________________________

3. Telephone Number ______________________________

4. Name of Laboratory Director ______________________________

5. Provide an organization chart of the laboratory, including any field operations or other internal affiliations to show how the laboratory fits into the general organizational structure. If attached, please check.

6. List names and addresses of external organizations used for significant supporting technical services.

   ______________________ ______________________

   ______________________ ______________________

   ______________________ ______________________

7. List names of principal users of services of the laboratory.

   ______________________ ______________________

   ______________________ ______________________

   ______________________ ______________________

8. Has the laboratory been evaluated previously? Yes ☐ No ☐ If yes, when ____________ by whom ____________

9. Do you perform monitoring activities? Yes ☐ No ☐ If yes, please check nature of monitoring activity:

   ☐ Water Quality
   ☐ Estuaries
   ☐ Oceans
   ☐ NPDES
   ☐ Air-Ambient
   ☐ Air-Source
   ☐ Pesticides
   ☐ Radiation
   ☐ Other (specify) ____________

Lab Name ____________________

10. Do you participate in enforcement actions, emergency episodes, or special studies? Please specify.

____

____

11. Provide a copy of the latest annual report of the laboratory.

☐ Attached ☐ Not Available

Completed by ____________________ Date ____________________
NAME TITLE

Lab Name ______________________

PART 2. PERSONNEL

1. Laboratory staff. Complete Chart A for all technical personnel, including the laboratory director.

2. Provide brief summary job description for each supervisory, professional, and technical position. If attached, please check. ☐

3. What is the total number of laboratory employees? __________ Has this number increased over the past five years? Check if yes ☐

4. What portion of your staff participated in a formal training program related to improving work performance during the past year? Number __________ % __________

5. What was your turnover rate during the last 12 months?
   a) Administrative Staff Number __________ % __________
   b) Technical Staff Number __________ % __________

6. What portion of your staff was formally evaluated for performance during the past year? Number __________ % __________

7. What portion of your staff received merit increases in grade or salary during the past year? Number __________ % __________

8. What portion of your staff received service increases in grade or salary during the past year? Number __________ % __________

Completed by ______________________________ Date ______________
NAME TITLE

Lab Name ______________

CHART A

Complete Chart A for all technical personnel, including the laboratory director. Use a separate block for each employee and arrange the presentation to reflect the lines of organizational responsibility.

Date ____________ No. ____ of ____ pages.

Name	Training		Position	Years of Experience		Identify Analyses Performed by Numbers From Attached Index
	Degree (Circle One)	Major		Present Job	Previous Jobs	
	Ph.D. MS BS Assoc. HS					
	Ph. D. MS BS Assoc. HS					
	Ph. D. MS BS Assoc. HS					

Lab Name ______________________

PART 3. LABORATORY SPACE AND FACILITIES

CHART B

Complete Chart B. Please indicate both the availability and the adequacy of laboratory equipment and facilities.

Item	Description	Adequate		Additional Information
		Yes	No	
Buildings in Use Total m^2 (Sq. Ft.)				
Office Space Total m^2 (Sq. Ft.)				
Lab Space Total m^2 (Sq. Ft.)				
Bench-top Space Total m^2 (Sq. Ft.)				
Bench Hoods No. ____ Capacity (m/sec.) (lin. ft./min.)				

	Available		Adequate		Additional Information
	Yes	No	Yes	No	
Storage Space Chemicals					
Sample Storage - General					
Secured Space					
Refrigerated Space					
Hazardous Samples					
Controlled Space - Temperature					
Humidity					
Noise Insulation					
Shielded					
Clean Rooms					
Heat					
Air-Conditioning					
Electrical Services					
Gas					
Compressed Air					

Item	Available		Adequate		Additional Information
	Yes	No	Yes	No	
Vacuum					
Safety Equipment - Fire Alarm					
Fire Extinquishing Equipment					
Emergency Showers					
Eye Fountains					
Personal Equipment: glasses, gloves					
Hazardous Area Escape					
Flammable Material Storage					
Safety Cans					
Ventilation					
Smoking Areas					
Handling Equipment for Acids,					
Caustic					
OSHA Signs					
Water Supply - Distilled					
Deionized					
Ammonia - free					
CO_2 - free					
Bacteriologically Suitable					
Glassware Supply					
Glassware Washing Equipment					
Disposal Equipment - Broken Glass					
Contaminated Material, Solvents					
Library					
Conference Room					
Employee Lounge					
Employee Lockers					
Drinking Fountains					
Lunch Room					
Data Processing Equipment					

	Available		Adequate		Additional Information
	Yes	No	Yes	No	
Logistic Services - Telephone					
Intercom					
Emergency Line					
Motor Vehicle					
Facilities as a Whole					

Completed by ______________________________ Date ____________________

NAME TITLE

PART 4. TECHNICAL SERVICES OFFERED

Instructions

In Chart C, Table of Analytical Methods, you are asked to indicate the tests which are performed by this laboratory and the specific method(s) which you use for each test. This may be done simply by circling the appropriate references under Method Used in This Laboratory. In cases where you follow an EPA method which refers to ASTM or Standard Methods for the detailed procedure, you may circle the EPA reference only.

The Standard Methods, ASTM, and EPA references are given for your convenience. Standard Methods refers to Standard Methods for the Examination of Water and Wastewater, 13th Edition, 1971, published jointly by the American Public Health Association, the American Water Works Association, and the Water Pollution Control Federation. ASTM refers to the Annual Book of ASTM Standards, Part 31, Water, 1974, published by the American Society for Testing and Materials. EPA refers to Methods for Chemical Analysis of Water and Wastes, 1974, published by the Environmental Monitoring and Support Laboratory (National Environmental Research Center, Cincinnati, Ohio) and the Office of Technology Transfer, U.S. Environmental Protection Agency or to the Federal Register (for air tests). References in Standard Methods and ASTM are to method numbers, whereas references in the EPA Manual are to page numbers in the 1974 edition.

If this laboratory uses an alternate method or a modification of a referenced method, write "Other" under "Method Used in This Laboratory" and provide the requested information for each such case on a copy of the form "Alternate Analytical Method", page 40.

Under "Sample Frequency," please enter, in the #/Month column, the average number of samples per month tested by the specified method over the last 12 months. In the Peak Load column, give the maximum number of samples analyzed in a one-month period during the last 12 months. Your best estimates of these numbers will be satisfactory.

The tests listed in Chart C are limited to those referenced in the Federal Register. Referenced in the Federal Register but not included in Chart C are the variations in air methods suitable for measurement of emissions from stationary sources. Refer to Federal Register Vol. 36, No. 247, Part II, December 23, 1971; Vol. 38, No. 111, June 11, 1973; Vol. 39, No. 47, March 8, 1974; Vol. 40, No. 152, August 6, 1975; and Vol. 80, No. 194, October 6, 1975. There are, however, important areas not yet covered by such references. Biology is one such area. The bibliography appended to this procedure lists some of the sources of information on missing tests. Method 406, Standard Plate Count, is found in Standard Methods (Ref. 4). Refer also to the so-called "Equivalency Document," Federal Register, February 18, 1975.

At the end of Chart C a blank chart is included, page 20, on which information may be supplied on important tests performed by the laboratory which are not included in the check list.

Lab Name ______________________

1. Complete Chart C indicating analytical methodology which the laboratory wishes to have evaluated.
2. Provide a brief description of any special or unusual technical capability provided by the laboratory.

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3. Provide a brief description of methods that you use for pretreatment of samples before analysis for trace metals, Tests No. 16-43

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Completed by ______________________ Date ______________________

NAME TITLE

CHART C. TABLE OF ANALYTICAL METHODS

Lab Name: ____________

Test and Unit	Method	Method Used in This Lab			Copy Available	Sample Frequency	
		Circle Appropriate Reference[1] Check next col. if copies available in lab.				# / Month	Peak Load
		Standard Method	ASTM	EPA			
General Analytical Tests:							
1. Alkalinity as $CaCO_3$ ($mg\ CaCO_3$/liter)	(a) Electrometric Titration, Manual	201	D1067-70B	p. 3			
	(b) Electrometric Titration, Automated	201		p. 3			
	(c) Automated, Methyl Orange			p. 5			
2. Biochemical Oxygen Demand (B.O.D.) 5-day 20° C (mg/liter)	(a) Modified Winkler with Full-Bottle	219		p. 11, 51			
	(b) Probe Method			p. 11, 56			
3. Chemical Oxygen Demand (C.O.D.) (mg/liter)	(a) Dichromate Reflux (organic C > 15 mg/liter)	220	D1252-67	p. 20			
	(b) Low Level Modification			p. 21			
	(c) Saline Water Modification (C1 > 2000 mg/liter)			p. 25			
4. Total Solids (Total Residue) (mg/liter)	(a) Gravimetric, Dried at 103-105° C	224A		p. 270			
5. Total Dissolved Solids (Total Filterable Residue) (mg/liter)	(a) Glass Fiber Filtration, Dried at 180° C	224E		p. 266			

Test and Unit	Method	Method Used in This Lab			Copy Available	Sample Frequency	
		Circle Appropriate Reference[1] Check next col. if copies available in lab.				# / Month	Peak Load
		Standard Method	ASTM	EPA			
6. Total Suspended Solids (Total Nonfilterable Residue) (mg/liter)	(a) Glass Fiber Filtration, Dried at 103-105° C	224C		p. 268			
7. Total Volatile Solids (Volatile Residue) (mg/liter)	(a) Gravimetric, Dried at 550° C	224B		p. 272			
8. Ammonia (as N) (mg/liter)	(a) Distillation and Titration			p. 159			
	(b) Distillation and Nesslerization			p. 159			
	(c) Distillation and Ammonia Electrode			p. 159, 165			
	(d) Automated Colorimetric Phenate Method			p. 168			
9. Total Kjeldahl Nitrogen (as N) (mg/liter)	(a) Digestion, Distillation & Titration	216		p. 175-181			
	(b) Digestion, Distillation & Nesslerization			p. 175-181			
	(c) Digestion, Distillation & Ammonia Electrode			p. 165, 175-181			
	(d) Automated Phenate Method			p. 182			
10. Nitrate (as N) (mg/liter)	(a) Cadmium Reduction Method (Nitrate-Nitrite)	213B	D992-71	p. 201			

Test and Unit	Method	Method Used in This Lab: Circle Appropriate Reference[1] Check next col. if copies available in lab. Standard Method	ASTM	EPA	Copy Available	Sample Frequency: # / Month	Sample Frequency: Peak Load
10. Nitrate (as N) (mg/liter) (Cont.)	(b) Automated Cadmium Reduction Method (Nitrate-Nitrite)			p. 207			
	(c) Brucine Method			p. 197			
	(d) Automated Hydrazine Reduction Method			p. 185[2]			
11. Total Phosphorus (as P) (mg/liter)	(a) Single Reagent (Ascorbic Acid Reduction Method)	223CIII 223F		p. 249			
	(b) Automated Colorimetric Ascorbic Acid Reduction Method			p. 256			
	(c) Automated $SnCl_2$ Method	223E					
12. Acidity (mg $CaCO_3$/liter)	(a) Hydrogen Peroxide Digestion & Electrometric Titration		D1067-70E	p. 1			
	(b) Hydrogen Peroxide Digestion & Phenolphthalein End-Point Titration		D1067-70E				
13. Total Organic Carbon (T.O.C.) (mg/liter)	(a) Combustion and Infrared Method CO_2	138A	D2579-74	p. 236			
	(b) Combustion & Flame Ionization Method (CH_4)			p. 236			

Test and Unit	Method	Method Used in This Lab			Copy Available	Sample Frequency	
		Circle Appropriate Reference[1] Check next col. if copies available in lab.					
		Standard Method	ASTM	EPA		# / Month	Peak Load
14. Total Hardness (mg $CaCO_3$/liter)	(a) EDTA Titration	122	D1126-67B	p. 68			
	(b) Automated Colorimetric			p. 70			
	(c) Atomic Absorption (Ca + Mg)			p. 78-91, 103, 114			
15. Nitrite (as N) (mg/liter)	(a) Manual Colorimetric Diazotization			p. 215			
	(b) Automated Colorimetric Diazotization			p. 207*			

CHART C. TABLE OF ANALYTICAL METHODS

Lab Name: ____________________

Test and Unit	Method	Method Used in This Lab			Copy Available	Sample Frequency	
		Circle Appropriate Reference[1] Check next col. if copies available in lab.				# / Month	Peak Load
		Standard Method	ASTM	EPA			
Tests for Trace Metals:							
16. Aluminum (mg/liter)	(a) Atomic Absorption	103A		p. 92 Ψ			
17. Antimony (mg/liter)	(a) Atomic Absorption			p. 94 Ψ			
18. Arsenic (mg/liter)	(a) Atomic Absorption (Gaseous Hydride Method)			p. 95 Ψ			
	(b) Gaseous Hydride - Silver Diethyldithiocarbamate Colorimetric	104A		p. 9			
19. Barium (mg/liter)	(a) Atomic Absorption	129A		p. 97 Ψ			
20. Beryllium (mg/liter)	(a) Atomic Absorption	129A		p. 99 Ψ			
	(b) Aluminon Method	106B					
21. Boron (mg/liter)	(a) Curcumin Method	107A		p. 13			
22. Cadmium (mg/liter)	(a) Atomic Absorption	129A	D2576-70	p. 101 Ψ			
	(b) Dithizone Colorimetric Method	211(II)B					
23. Calcium (mg/liter)	(a) Atomic Absorption		D2576-70	p. 103 Ψ			
	(b) EDTA Titration	110C		p. 19			

Test and Unit	Method	Method Used in This Lab			Copy Available	Sample Frequency	
		Circle Appropriate Reference[1] Check next col. if copies available in lab.					
		Standard Method	ASTM	EPA		# / Month	Peak Load
24. Chromium VI (mg/liter)	(a) Extraction and Atomic Absorption			p. 78-91, 105 Ψ			
	(b) Diphenylcarbazide Colorimetric	211(II)D					
25. Chromium, Total (mg/liter)	(a) Atomic Absorption	129A	D2576-70	p. 78-91, 105 Ψ			
	(b) Oxidation & Diphenylcarbazide Colorimetric	211(II)C	D1687-67	p. 105			
26. Cobalt (mg/liter)	(a) Atomic Absorption		D2576-70	p. 107 Ψ			
27. Copper (mg/liter)	(a) Atomic Absorption	129A	D2576-70	p. 108 Ψ			
	(b) Neocuproine Colorimetric	211(II)E	D1688-68				
28. Iron (mg/liter)	(a) Atomic Absorption	129A	D2576-70F	p. 110 Ψ			
	(b) O-Phenanthroline Colorimetric	211(II)F	D1068-68A				
29. Lead (mg/liter)	(a) Atomic Absorption	129A	D2576-70G	p. 112 Ψ			
	(b) Dithizone Colorimetric	211(II)G					
30. Magnesium (mg/liter)	(a) Atomic Absorption	129A	D2567-70	p. 114 Ψ			
	(b) Gravimetric	127A	D511-52				
31. Manganese (mg/liter)	(a) Atomic Absorption	129A	D2567-70	p. 116 Ψ			

Test and Unit	Method	Method Used in This Lab			Copy Available	Sample Frequency	
		Circle Appropriate Reference[1] Check next col. if copies available in lab.				# / Month	Peak Load
		Standard Method	ASTM	EPA			
32. Mercury (mg/liter)	(a) Flameless Atomic Absorption: Manual Cold Vapor Technique (Hg in Water)		D3223-73	p. 118 Ψ			
	(b) Flameless Atomic Absorption: Automated Cold Vapor Technique (Hg in Water) (not approved generally)			p. 127 Ψ			
	(c) Flameless Atomic Absorption: Manual Cold Vapor Technique (Hg in Sediment)		D3223-73	p. 134 Ψ			
33. Molybdenum (mg/liter)	(a) Atomic Absorption			p. 139 Ψ			
34. Nickel (mg/liter)	(a) Atomic Absorption		D2576-70	p. 141 Ψ			
	(b) Heptoxime Colorimetric	211(II)I					
35. Potassium (mg/liter)	(a) Atomic Absorption			p. 143 Ψ			
	(b) Colorimetric	147B					
	(c) Flame Photometric	147A	D1428-64				
36. Selenium (mg/liter)	(a) Atomic Absorption (Gaseous Hydride Method)			p. 145 Ψ			
37. Silver (mg/liter)	(a) Atomic Absorption	129A		p. 146 Ψ			

CHART C. TABLE OF ANALYTICAL METHODS

Lab Name: ____________

Test and Unit	Method	Method Used in This Lab			Copy Available	Sample Frequency	
		Circle Appropriate Reference[1] Check next col. if copies available in lab.					
		Standard Method	ASTM	EPA		# / Month	Peak Load
Tests for Nutrients, Anions, and Organics							
44. Organic Nitrogen (as N) (mg/liter)	(a) Kjeldahl Nitrogen minus Ammonia Nitrogen	215		See (8) and (9) above			
45. Orthophosphate (as P) (mg/liter)	(a) Single Reagent Ascorbic Acid Reduction Method	223F	D515-72A	p. 249			
	(b) Automated Colorimetric Ascorbic Acid Reduction Method			p. 256			
46. Sulphate (as SO_4) (mg/liter)	(a) Gravimetric	156A	D516-68A	p. 283			
	(b) Turbidimetric	156C	D516-68B	p. 277			
	(c) Automated Colorimetric Barium Chloranilate			p. 279			
47. Sulfide (as S) (mg/liter)	(a) Titrimetric Iodine	228A		p. 284			
48. Sulfite (as SO_3) (mg/liter)	(a) Titrimetric Iodide-Iodate	158	D1339-72C	p. 285			
49. Bromide (mg/liter)	(a) Titrimetric Iodide-Iodate		D1246-68C	p. 14			
50. Chloride (mg/liter)	(a) Silver Nitrate	112A	D512-67B				
	(b) Mercuric Nitrate	112B	D512-67A	p. 29			
	(c) Automated Colorimetric Ferricyanide			p. 31			

Test and Unit	Method	Method Used in This Lab			Copy Available	Sample Frequency	
		Circle Appropriate Reference[1] Check next col. if copies available in lab.					
		Standard Method	ASTM	EPA		# / Month	Peak Load
51. Cyanide, Total (mg/liter)	(a) Distillation & Silver Nitrate Titration	207A, 207B	D2036-74A	p. 40			
	(b) Distillation & Pyridine-Pyrazolone (or Pyridine - Barbituric Acid) Colorimetric	207A, 207C	D2036-74A	p. 40			
52. Fluoride (mg/liter)	(a) Distillation-SPADNS	121A, 121C	D1179-72A	p. 59			
	(b) Automated Complexone Method			p. 61			
	(c) Fluoride Electrode			p. 65			
53. Chlorine, Total Residual (mg/liter)	(a) Starch-Iodide Titration	204A	D1427-68A	p. 35			
	(b) Amperometric Titration	204A	D1427-68B	p. 35			
54. Oil and Grease (mg/liter)	(a) Gravimetric (Separatory Funnel Extraction)	137		p. 229			
	(b) Infrared (Separatory Funnel Extraction)			p. 232			
55. Phenols (mg/liter)	(a) Colorimetric (4-AAP Method with Distillation)	222E	D1783-70	p. 241			

Test and Unit	Method	Method Used in This Lab			Copy Available	Sample Frequency	
		Circle Appropriate Reference[1] Check next col. if copies available in lab.					
		Standard Method	ASTM	EPA		# / Month	Peak Load
56. Surfactants (mg/liter)	(a) Methylene Blue Colorimetric	159A	D2330-68	p. 157			
57. Algicides (mg/liter)	(a) Gas Chromatography			§			
58. Benzidine (mg/liter)	(a) Diazotization & Colorimetric			†			
59. Chlorinated Organic Compounds (Except Pesticides) (mg/liter)	(a) Gas Chromatography			§			
60. Pesticides (mg/liter)	(a) Gas Chromatography			§			
	(b) Thin Layer Chromatography			§			

CHART C. TABLE OF ANALYTICAL METHODS

Lab Name: ____________

Test and Unit	Method	Method Used in This Lab			Copy Available	Sample Frequency	
		Circle Appropriate Reference[1] Check next col. if copies available in lab.					
		Standard Method	ASTM	EPA		# / Month	Peak Load
Physical and Biological Tests							
61. Color	(a) Platinum-cobalt Colorimetric	118		p. 36			
	(b) Spectrophotometric (Dominant wavelength, hue, luminance, purity)	206A		p. 39			
62. Specific Conductance (mho/cm @ 25° C)	(a) Wheatstone Bridge	154	D1125-64	p. 275			
63. Turbidity (Jackson Units)	(a) Turbidimeter Method	163A	D1889-71 (Sect. 10-16)	p. 295			
64. Streptococci Bacteria, Fecal (number/100 ml)	(a) MPN	409A					
	(b) Membrane Filter	409B					
	(c) Plate Count	409C					
65. Coliform Bacteria, Fecal (number/100 ml)	(a) MPN	407C					
	(b) Membrane Filter	408B					
66. Coliform Bacteria, Total (number/100 ml)	(a) MPN	407A					
	(b) Membrane Filter	408A					

CHART C. TABLE OF ANALYTICAL METHODS

Lab Name: ____________________

Test and Unit	Method	Method Used in This Lab			Copy Available	Sample Frequency	
		Circle Appropriate Reference[1] Check next col. if copies available in lab.					
		Standard Method	ASTM	EPA		# / Month	Peak Load
Radiological Tests							
67. Alpha, Total (pCi/liter)	(a) Proportional Counter	302	D1943-66				
	(b) Scintillation Counter		D1943-66				
68. Alpha, Counting Error (pCi/liter)	(a) Proportional Counter	302	D3085-72T				
	(b) Scintillation Counter		D3085-72T				
69. Beta, Total (pCi/liter)	(a) Proportional Counter	302	D1890-66				
70. Beta Counting Error (pCi/liter)	(a) Proportional Counter	302	D3085-72T				
71. Radium, Total (pCi/liter)	(a) Proportional Counter	304	D2460-70				
	(b) Scintillation Counter	304,305	D2460-70				

CHART C. TABLE OF ANALYTICAL METHODS

Lab Name: ______________

Test and Unit	Method	Method Used in This Lab			Copy Available	Sample Frequency	
		Circle Appropriate Reference[2] Check next col. if copies available in lab.					
		Standard Method	ASTM	EPA		# / Month	Peak Load
Tests for Other Characteristics							
72. Temperature	(a) Thermometer or Thermistor	162		p. 286			
73. pH	(a) Electrometric	144A	D1293-65	p. 239			

CHART C. TABLE OF ANALYTICAL METHODS

Lab Name: ____________

Test and Unit	Method	Method Used in This Lab			Copy Available	Sample Frequency	
		Circle Appropriate Reference Check next col. if copies available in lab.					
		Standard Method	ASTM	EPA		# / Month	Peak Load
Tests for Air Characteristics							
74. Sulphur Dioxide	(a) Pararosaniline Method { Manual Automated			b.22385-7 ϕ			
75. Suspended Particulates	(a) High Volume Method			b.22388-90 ϕ			
76. Carbon Monoxide	(a) Nondispersive Infrared Spectrometry			b.22391 ϕ			
77. Photochemical Oxidants (Ozone)	(a) Chemluminescence, Continuous			b.22392 ϕ			
78. Hydrocarbons (minus Methane)	(a) GC-FID			b.22394 ϕ			
79. Nitrogen Dioxide	(a) Arsenite 24-Hr Sampling Method Manual Automated			b.15175 ▽ 22396 ϕ			
	(b) Chemluminescence, Continuous			b.15177 ▽			

Chart C. Table of Analytical Methods

Lab Name: ______________________

Test and Unit	Method	Method Used in This Lab Give Method Number or Page Check next col. if copies available in lab.			Copy Available	Sample Frequency	
		Standard Method	ASTM	EPA		# / Month	Peak Load
Non-referenced Tests in Use							

REFERENCE MARKS IN CHART C

1 - Federal Register, Vol. 38, No. 199, October 16, 1973.

2 - EPA Methods Manual, 1971.

Ψ - An introduction to atomic absorption spectrophotometry and a general procedure for trace metal analysis by atomic absorption is given in EPA Manual, pp. 78-91.

§ - Interim procedures for algicides, chlorinated organic compounds, and pesticides obtained from the Environmental Monitoring and Support Laboratory, USEPA, Cincinnati, Ohio 45268.

† - Estimated by the method of M.A. El-Dib, "Colorimetric Determination of Aniline Derivatives in Natural Waters," Journal of the Association of Official Analytical Chemists, Vol. 54, No. 6, November, 1971, pp. 1383-1387.

▽ - Federal Register, Vol. 38, No. 110, June 8, 1973.

ϕ - Federal Register, Vol. 36, No. 228, November 25, 1971.

* - Without Cd reduction.

ALTERNATE ANALYTICAL METHOD

Name of Laboratory ____________________

(a) # ________ Test: ____________________

(b) If this is a modification of a referenced method,

(1) Which referenced method (give manual name and pages)? ____________________

(2) Purpose of modification: ____________________

(3) Brief description of modification: ____________________

(4) Literature reference, if any: ____________________

(c) If this is an alternate method,

(1) Purpose of use of alternate method: ____________________

(2) Brief description of method: ____________________

(3) Literature reference, if any: ____________________

(d) Have you applied to EPA for approval of this procedure? (c.f., Federal Register, Vol. 38, No. 199, October 16, 1973, p. 28760)

Lab Name ____________________

PART 5. ANALYTICAL INSTRUMENTS AND SPECIAL APPARATUS

(1) Complete Chart D indicating analytical instruments and special apparatus available in the laboratory. See complete list of equipment, by analytical method, in the Appendix.

Completed by ____________________ ____________________ Date ____________________

NAME TITLE

INDEX OF ANALYTICAL INSTRUMENTS AND SPECIAL APPARATUS

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Lab Name ____________________

CHART D. ANALYTICAL INSTRUMENTS AND SPECIAL APPARATUS

Identify the instruments and apparatus in use and in good working condition in your laboratory.

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
1. **Technicon Autoanalyzer**					
AAI Units ______					
AAII Units ______					
Samplers ______					

Manifolds for:

☐ Alkalinity

☐ Ammonia Nitrogen (Colorimetric Phenate)

☐ Kjeldahl Nitrogen (Colorimetric Phenate)

☐ Kjeldahl Nitrogen (Selenium Method)

☐ Nitrate-Nitrite (Cd Reduction)

☐ Total Phosphorus or Orthophosphate

☐ Total Hardness

☐ Mercury (Cold Vapor Technique)

☐ Sulphur (Chloranilate)

☐ Chloride (Ferricyanide)

☐ Fluoride (Complexone)

☐ Phenols (4-AAP)

☐ Others (Specify):

____

____

Analytical Cartridges for:

☐ Ammonia Nitrogen (Colorimetric Phenate)

☐ Total Phosphorus or Orthophosphate

☐ Nitrate-Nitrite (Cd Reduction)

☐ Others (Specify):

____

____

Accessory	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
Colorimeters ____					

Cells, tubular flow (Give number of each type.)

☐ 15 mm

☐ 50 mm

Filters:

Wavelength of Max. Transmittance

Wavelength of Max. Transmittance

Accessory	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
Recorders ____					

☐ Range Expansion

☐ Digital Printer

Associated Apparatus:

☐ Continuous Filter
☐ Proportioning Pump
☐ Planetary Pump
☐ Vapor-liquid Separator (for Hg Cold Vapor)
☐ Continuous Digester
☐ Others (Specify):

☐ Heating Bath
☐ 45° - 80° C Range
☐ With Distillation Coil & Head
☐ With Double Delay Coil
☐ High Temperature with 2 Distillation Coils

____

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
2. Colorimeters/Filter Photometers Range: ____					
Range: ____					

Filters:

Wavelength of Max. Transmittance	Bandwidth

Wavelength of Max. Transmittance	Bandwidth

Special Associated Apparatus (Specify): ____

____ ____

____ ____

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
3. Spectrophotometers (UV - visible) Recording (Range:) ____					
Manual (Range:) ____					

Special Attachments (Specify): ____

____ ____

____ ____

Metal	Lamps			Fuels				
	Hollow Cathode	Electric Discharge	Other (Specify)	Acetylene	Air	Nitrous Oxide	Argon	Hydrogen
Magnesium								
Manganese								
Mercury (Cold Vapor)								
Molybdenum								
Nickel								
Potassium								
Selenium (Gaseous Hydride)								
Silver								
Sodium								
Thallium								
Tin								
Titanium								
Vanadium								
Zinc								

Associated Equipment:

☐ Spectrophotometric gas cells, 10 cm, quartz windows (for Hg Cold Vapor)

☐ Mercury Cold Vapor Setup

☐ Others (Specify): ______________________

____

____

____

____

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
4. Atomic Absorption Spectrophotometers					

Recorders (Specify):

Indicate lamps and fuels used for each metal:

Metal	Lamps			Fuels				
	Hollow Cathode	Electric Discharge	Other (Specify)	Acetylene	Air	Nitrous Oxide	Argon	Hydrogen
Aluminum								
Antimony								
Arsenic (Gaseous Hydride)								
Barium								
Beryllium								
Cadmium								
Calcium								
Chromium VI								
Chromium, Total								
Cobalt								
Copper								
Iron								
Lead								

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
5. **Mercury Analyzers** Technique:					
Range:					
Sensitivity:					

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
6. **Flame Photometers** Direct Reading:					
Internal Standard:					

Special Apparatus:

☐ Setup for Na in low-solids water (Air blower & filter, Oxy-hydrogen flame, polyethylene, or Teflon apparatus)

☐ Others (Specify):

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
7. **Infrared Spectrophotometers** Single Beam (Range:)					
Double Beam (Range:)					
Special Features:					
IR Cells (Specify):					

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
8. Conductivity Meters					
Field (Cell Type:)					
Laboratory (Cell Type:)					

Associated Apparatus (Specify): ______________________________

____

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
9. Electrometric Apparatus					
Electrometers:					
Field - ASTM Type I					
ASTM Type II					
Laboratory - ASTM I					
ASTM II					

Electrodes:	Manufacturer	Type
pH		
Dissolved Oxygen		
Ammonia		
Fluoride		
Cyanide		
Other (Specify):		

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
10. Automatic Titrimeters					

Recorders (Specify): ______

Frequently Used Electrodes (Specify): ______

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
11. Amperometric Titration Apparatus					

Instrument		# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
12. Analytic Balances						
Capacity	**Sensitivity**					

Certified Weights ☐ Certification ______

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
13. Carbon Analyzers Infrared (as CO_2) ______					
Flame Ionization (as CH_4) ______					

Instrument	# Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
14. Nephelometers/ Turbidimeters Range: ______					
Sensitivity Below 1 NTU: ______					

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
15. Blenders ______					

Instruments	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
16. Vacuum Pumps Type: ______					
Type: ______					

Apparatus	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
17. Magnetic Stirrers With Heater ______					
______					
With Timer ______					
______					

18. Drying Ovens

☐ 98° C ☐ 103°-105° C ☐ 180° C

19. Muffle Furnance

☐ 550° C

20. Hot Plate (persulphate digestion) ☐

Autoclave (persulphate digestion) ☐

21. Water Baths/Incubators

☐ 10°-15° C

☐ 100° C, well stirred, with Neoprene coated wire rack for 40-50 ml sample tubes (for Brucine Nitrate Method)

☐ 25° C with rack (for conductance measurements)

☐ 20° C incubator (for B.O.D.) with circulator

22. B.O.D. Incubation Bottles **Number** ____________________

23. Gravimetric Evaporating/Weighing Dishes	**Number**
Porcelain	____________________
Vycor	____________________
Platinum	____________________

Apparatus	**Number**
24. Dessicators Type: ____________________	
Type: ____________________	

Apparatus	**Number**
25. Kjeldahl Distillation Apparatus Macro ____________________	
Micro ____________________	

Apparatus	**Number**
26. Arsine Generator & Absorption Apparatus ____________________	

Apparatus	**Number**
27. Cyanide Distillation Apparatus ____________________	

Apparatus	**Number**
28. Soxhlet Extraction Apparatus Thimble Size: ____________________	

Apparatus	**Number**
29. Phenol Distillation Setups ____________________	

Apparatus	Number
30. Nessler Tubes, matched sets, APHA standard	
50 ml, tall ______	
100 ml, tall ______	

Apparatus	Model	Temperature	Cubic Feet
31. Refrigerators			

Apparatus	Certification	Range
32. Special Thermometers		

Apparatus
33. Thin-Layer Chromatography Apparatus (Describe chambers; plates, commercial or homemade; spray reagents and apparatus; spotting apparatus; special equipment)

______

______

______

______

______

______

34. **Column Chromatography Apparatus** (Describe columns; adsorbents - type, source, grade, special handling; solvent evaporation apparatus; special equipment)

35. **Gas Chromatographs** (Describe for each instrument: make and model; column type-capillary, 1/8 in., 1/4 in., etc., temperature programming; detector type and model; recorder; most commonly used columns; special equipment)

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
36. Other Special Instruments (Mass Spec., NMR, Flowmeters, Electrom Microscope, etc.)					

CHART D. ANALYTICAL INSTRUMENTS AND SPECIAL APPARATUS

Lab Name: ____________________

Special Microbiological Equipment

37. Incubation Oven 35 ± 0.5° C ☐

☐ Humidity controlled? (Specify relative humidity) ____________________

38. Water Baths

☐ 35 ± 0.5° C ☐ 44.5 ± 0.2° C

39. Autoclave (to 121° C) ☐

	# of Units	Manufacturer	Magnification	Light Source
40. Light Microscope				
Type: ____________________				
Type: ____________________				

	Plastic	Glass	Other (Specify)
41. Miscellaneous Microbiological Containers Sample Bottles			
Inoculation Tubes			
Dilution Bottles			
Containers for Media			
Petri Dishes			
Other (Specify)			

	Manufacturer	Type
42. Membrane Filters		

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
43. Colony Counters					

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
44. Other Microbiological/Biological Instrumentation					

CHART D. ANALYTICAL INSTRUMENTS AND SPECIAL APPARATUS

Lab Name: ____________

Special Radiological Equipment

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
45. **Alpha & Beta Particle Counters** Windowless Gas-Flow Proportional Counter					
Thin Window Gas-Flow Proportional Counter					
Alpha Scintillation Counter					
Beta Scintillation Counter					
Liquid Scintillation Counter					

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
46. **Spectrometer Systems** Alpha Spectrometer (Surface Barrier Type)					
Detector					
Analyzer					
Other Pertinent Information					

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
46. Spectrometer Systems (Con't.)					
Gamma Spectrometer					
Detector					
Analyzer					
Other Pertinent Information					

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
47. Other Radiological Instrumentation (Radon Gas Counters, Survey Instruments, etc.)					

CHART D. ANALYTICAL INSTRUMENTS AND SPECIAL APPARATUS

Lab Name: ____________________

Special Air Monitoring Equipment

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
48. Sulphur Dioxide Monitor (Field Sampling/Lab Analysis)					
Field Sampler ____________					
Lab Analytical Method: ____________					
(Field Sampling/Field Analysis)					
Field Sampler/Analyzer ____________					
Analytical Method: ____________					

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
49. Suspended Particulates (High Volume Sampler)					
Filter Type ____________					

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
50. Carbon Monoxide Monitor					

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
51. Total Hydrocarbons (corrected for CH_4) Monitor					

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
52. **Photochemical Oxidants** (O_3) Monitor					

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
53. Nitrogen Dioxide Monitor (Field Sampling/ Lab Analysis) Field Sampler					
Lab Analytical Method:					
(Field Sampling/ Field Analysis) Field Sampler/Analyzer					
Analytical Method:					

Instrument	# of Units	Manufacturer	Model	Year Purchased	Operating Manual Avail. in Lab.
54. Other Air Monitoring Equipment Including Calibration Equipment ______					
Permeation Tubes					
Standard Cylinders					
Gas Phase Titration-Commercial					
-Home Made					
Air Dilution Systems					
Variable Temperature Bath: 25° C ± 0.1° C					

INTERNAL AND EXTERNAL CONTROLS

The first three sections of this chart contain lists on which the availability of written operating procedures is to be checked. These parts cover instrument maintenance and calibration, all aspects of sampling, and the quality control program of the laboratory. You may be asked to show these documents to the evaluator during the onsite inspection and to discuss them with him.

This check list should not be looked upon as a demand for written procedures (for example, a Quality Control Program) in a particular standard format. The important thing is that the principal laboratory controls should be documented in a permanent way. Some procedures may be brief or may not include all of the items to be checked. In the list please check those items which you believe to be adequately documented. The onsite visit will provide an opportunity to discuss the completeness of the documentation with the evaluator.

Part 4 of this chart asks for information on participation in interlaboratory proficiency testing programs. Information is required on the test methods covered in any plan in which you have participated, the organization conducting the program and the date of the last check sample reported upon.

You will be rated on the extent of your participation in such programs. However, as of the present, the actual standing you have achieved in proficiency tests is not a part of the scoring system for this evaluation.

Lab Name ______________________________

PART 6. INTERNAL AND EXTERNAL CONTROLS

CHART E

	Available	
	Yes	No
1. Control of Analytical Methods and Instruments		
(1) Written Instrument Maintenance and Calibration Procedures and Log Books		
(2) Written Bench Operating Procedures		
2. Control of Sampling and Sample Preservation		
(1) Written Sampling Procedures Covering:		
Sampling Plans and Sampling Equipment		
Sample Collection and Preservation		
Identification and Storage of Samples		
Laboratory Handling of Samples (Request for analysis, sample preparation, timely performance, etc.)		
(2) Written Description of the Chain of Custody of Samples		
(3) Written Procedures for Field Measurement (Flow, critical tests: D.O., Residual C1, etc.)		
(4) Written Procedures for Monitoring (Water supply, effluents, ambient air, stacks, mobile vehicles, pesticides, radiation, etc.)		
3. Quality Control		
(1) Written Quality Control Program Covering:		
Quality Policy		
Assignment of Responsibility		
Training in Quality Control Methods		
Control of Purchased Chemicals/Reagents		
Internal Field and Laboratory Checks:		
Precision/Accuracy		
Routine Duplicates, Spiked, and Standard Samples		
Statistical Methods, Including Control Charts and/or Computer Methods		
(2) Written Description of Lab Record System (Data handling/calculations, data review, validation and audit)		
(3) Written Description of Lab Report Systems		

(4) If you have a Quality Control Manual, please provide a copy. Attached ☐

4. Inter-laboratory Proficiency Testing Programs

Test Method	Participated in Program of:					Date of Last Check Sample	Within Acceptable Limits
	EPA	CDC	State	USGS	Other (Specify)		

Completed by: ______________________________ Date ______________
NAME TITLE

SECTION 5
EVALUATOR'S GUIDE

PART 1. GENERAL INFORMATION ABOUT THE LABORATORY

Appropriateness of Organization

Intent. To determine appropriateness of the organization to render the services offered by the laboratory. This protocol is primarily concerned with the laboratory's monitoring activities: analyses performed to determine compliance with laws and regulations. The organization should be suited to the media that the evaluation covers: air, water, pesticides, or radiation.

Request a short discussion of the organization as seen from management's viewpoint.

- Is the organization chart supplied with the preliminary information up-to-date? Does it agree with the actual organization?
- Do functions performed in the laboratory follow the organization chart exactly?
- Are problems handled strictly through chain of command or do sections of the laboratory interact to get timely solutions?
- Does the laboratory experience difficulty in meeting performance requirements?

Impairment of Functions

Intent. To determine whether management perceives problems that might lead to impairment of laboratory functions.

Request a brief oral description of any problems encountered in operating the laboratory. Ask specifically about the following:

- Does the laboratory have difficulties in obtaining a sufficient number of well qualified staff in all disciplines?

- Are the facilities, equipment and services adequate to perform the services offered in the media covered by the laboratory? Water? Air? Pesticides? Radiation?

- Does the laboratory have difficulties in getting adequate services from outside supporting organizations? Specifically, is it satisfied with the validity of sampling, performed for it by others? With testing? With calibration? Are reports from outside signed?

- Does the laboratory have any problems in budgeting for next year? Does it have separate budgets for routine operations and for equipment and apparatus? Who is responsible for preparing the different parts of the budget? Is there input from all levels of the organization?

- Does the laboratory have any problems in satisfying those who use its services?

Strength of Management

Intent. To discover something about the strength of management.

Request discussion on the following items.

- Does the laboratory experience difficulties in maintaining cooperation between different laboratory groups? Between supervisors and analysts?

- Does the laboratory have specific plans and procedures for rapid to-the-point internal communications?

- Does the laboratory prepare an annual plan for operation of the laboratory? A long-range plan? What is management's experience with performance according to plan?

- Does the laboratory have a policy manual? Does sufficient informal control exist to ensure that things that need to be done quickly get done, for example cross over lines of authority in the lab or change-orders for sample analyses?

- Refer to Preliminary Questionnaire, Part 1, Items 9 and 10, dealing with involvement in activities outside the laboratory. Is the level of involvement in these activities consistent with the expectations the user should have of the laboratory?

Objectivity of the Laboratory

Intent. To determine whether there are reasons for questioning or discounting the objectivity of the laboratory.

Request a brief discussion of the relationship of the laboratory with its own organization and with its customers. If laboratory is privately owned the enquiry should be deeper than for publicly controlled laboratories.

Inquire more about:

- Ownership
- Managerial structure and individuals in sensitive and controlling positions
- Any other affiliations of principal officers and directors and those in supervisory positions in laboratory
- Any chance of conflict of interest of individuals in management - in laboratory work
- Basis for funding other than fees for direct services performed.

Cooperation Obtained

Intent. To determine the degree of cooperation of the entire laboratory in the total evaluation procedure. If such cooperation is not evident, capability of management is questionable.

Request a brief oral description of how the preliminary questionnaire was handled. How were various sections distributed for completion? Who decided who would answer the different sections? How were personnel advised of the importance of cooperation in the evaluation? Try to discover:

- Reasons for not providing complete information
- Any plans for using results of evaluation for benefit of the laboratory.

PART 2. PERSONNEL

Before visit is made some scores can be assigned from data already received on Chart A, Preliminary Questionnaire, Section 4.

Supervisor Training

All personnel in supervisory positions should have a university degree. Under unusual circumstances experience in specific methodology used in environmental monitoring laboratories and experience in such a laboratory may be substituted; however, a non-degree person should have had 5-10 years of experience.

Supervisor Experience

Determine from questioning of each supervisor the pertinence of his experience to environmental monitoring problems, e.g.

- Laboratory and field experience
- Involvement in investigation of emergency episodes and enforcement actions
- Leadership in special studies
- Length of experience in operation of laboratory functions now engaged in.

Job Descriptions

Study job descriptions carefully to determine if indeed the jobs are carried out according to the description. Make notes about jobs beside each name on Chart A, Section 4, so that you can ascertain through conversation whether what he actually does compares closely with the position as described.

Training Program

Check information received on training programs. If no formal training program exists, more time will be required on the visit to determine what is done for training. Question individuals to determine if they have received any training since joining the laboratory. Ask how much time is devoted to training on starting employment at the laboratory and how it is continued.

Turnover Rate

The rate of turnover may serve as an unobtrusive measure of effective personnel management. A consistently high turnover rate may indicate operating problems which the management is not successfully handling. However, this is not the whole story because turnover rate may be due to causes beyond the laboratory management's control. Discreet questions may be asked about employment problems both of supervision and of analysts. Do personnel ceilings or funding problems interfere with administration of a sound salary policy? Are sound hiring procedures used for obtaining new personnel? Is hiring according to the crony system? Do Civil Service regulations apply? Is there a functioning affirmative action program?

General Morale

This question is related to the general morale and well being of the people employed at the laboratory. Determine by questions if any positive stpes are taken by the laboratory management to indicate some concern for individuals.

- Does management urge that training programs are taken either on site or at a nearby school?
- Is there a definite program for advancement?
- Are careful records kept on advancement?
- What is done regarding health programs?

The morale question is wider than whether policies exist and records are kept. Are employee organizations or unions in existence? What percentage of employees belong to unions? Ask analysts as well as supervisors about the state of relations between workers and management. Is there an opportunity for input by laboratory personnel into technical and management concerns of the laboratory?

PART 3. LABORATORY SPACE AND FACILITIES

Refer to Chart B, Preliminary Questionnaire, Section 4.

General Characteristics

The location of the laboratory, proximity to public transportation, its outside appearance, and a walk through of the building should help the evaluator to determine whether it is generally acceptable as an environmental monitoring laboratory.

Although many general features of the laboratory may have been checked in Chart B of the Preliminary Questionnaire, some discreet questions of laboratory personnel may be helpful.

- Is the location such that housing is available to the staff without excessive travel?
- Are there public eating facilities nearby, available for the entire staff?
- Is the neighborhood one that would cause no worry to any staff member who worked late?

Consider whether general support facilities are appropriate to the size and nature of the laboratory, i.e., secretarial and technician support, duplication facilities, photographic facilities, machine shop, electrical/electronics shop, glass blowing, etc.

Observe the adequacy of the visitor reception area, conference room, employee lounge or lunch room, locker space, drinking fountains, heating and air conditioning, service for electricity (Voltage stable?), gas, compressed air, and vacuum, etc. (filters installed?) Use Chart B as a guide, if desired.

Office Space

How does the square foot of office space per person compare to the adopted standard of 16.7 m^2 (180 sq. ft)?

Laboratory Space

How does the square foot of laboratory space per person compare to the adopted standard of 18.5 m^2 (200 sq. ft)?

Bench Top Space

How does the length of bench top per person compare to the adopted standard of 1.2m (4 ft)?

Hood Space and Operation

Examine hoods to make certain they operate properly. Ask, if in the opinion of the lab staff they are sufficient both in space and exhaust capability. Are records kept showing hood monitoring with velometer, last cleaning of ducts, general condition of glass, services, etc.? Filters last changed? Adopted standard 0.5 m/s (100 ft./min.).

Storage Space for Chemicals, Reagents, Glassware, and Supplies

The laboratory should have separate storage spaces for general chemicals, volatile chemicals and solvents, reagents, glassware and general supplies.

Closed cabinets should be used to keep bottles, glassware etc., free of dust and contamination from fumes.

Storage of volatile chemicals should meet OSHA standards: closed metal cabinet, under negative pressure, and away from flame/heat or sparks. (This may be storage under hood if under constant negative pressure).

No more than one liter each of volatile chemicals and solvents should be stored in the laboratory area. Larger amounts should be held in a separate storage facility away from the laboratory.

Use of carcinogenic/mutagenic chemicals should be kept to a minimum. If used these should be stored, handled and weighed in a glove box under constant negative pressure. Wherever possible, substitute chemicals or procedures should be used.

There should be sufficient in-lab storage available to permit the clearing of bench tops between test series. This is important for assurance of good control over procedures and for safety of the worker.

Storage areas should be inspected and corrected for overcrowding, breakage, outdated chemicals and general condition as a part of the routine lab clean-up.

Sample Storage

It is necessary not only that there be sufficient, accessible, well arranged storage space for general samples but also that provisions be made for special requirements of some samples, such as secured areas, refrigerated areas, and facilities for isolated storage of contaminated samples.

Controlled Space

The need for temperature and humidity control, for noise or electrical shielding and for clean rooms will depend on the media handled by the laboratory. Using answers given in preliminary questionnaire, Chart B, question staff about requirement if space is not available.

Safety Equipment/Procedures

An opportunity was given in the preliminary questionnaire to check availability of specific items of equipment. Check the condition of this equipment.

In addition, observe, or ask questions about safety related matters. Examples:

- Eye protections, respiratory protection, floors not slippery, trash cans adequate and emptied regularly, first aid kit available?
- Does lighting in the laboratory meet standard of 100 ft. candles at bench top? If possible, carry a light meter to place on benches and desks to actually measure amount of light.
- Are fire prevention regulations posted? Smoking rules?
- Is area use clearly marked?
- Is the fire alarm clearly audible?
- Are exits marked and illuminated?
- Are fire extinguishers conspicuously located and in working order? Inspected last?
- Are emergency telephone numbers posted?

  Fire_______________ Medical_______________

- Are regular fire drills conducted? When? Has local fire department ever visited laboratory? When?
- Does the laboratory give the appearance of having a constant awareness of the importance of safety?

Distilled Water/Deionized Water

Determine who is responsible for the stills which supply distilled water. Is there a central supply of deionized water? Are checking procedures written and a record maintained?

Glassware Supply and Washing

Is a sufficient supply of all the necessary types of glassware available? Is the glassware washing area convenient to work areas served? Is sufficient space provided for washing and drying? Are water supply, drains, drying ovens (165°C) and racks adequate? Are there written procedures for handling special glassware? Are contaminated containers sterilized or disinfected prior to washing? Are water spots present on recently washed ware? Are items tested for detergent removal (by appropriate indicator)? Is rinse water supply adequate? Are chipped or scratched items discarded? Are pipettes stored in aluminum or stainless steel (not copper) cans?

Housekeeping

Are passageways kept clear? Are broken glass and contaminated materials properly collected and disposed of? Are floors clean and well maintained? Are rooms and benches clean and uncluttered?

Data Processing Equipment and Logistic Services

Does laboratory have its own data processing facilities or access to a shared system? Is telephone service adequate? Is there an intercom system? Is there an emergency outside line? Is there a motor vehicle pool of any sort?

PART 4. ANALYTICAL METHODS

Refer to Chart C, Preliminary Questionnaire, Section 4.

Intent. The intent of the part is to determine actual laboratory practices in the conduct of tests. Discuss each test for which the laboratory is being evaluated with individual "bench analysts", or their immediate supervisors.

- Are copies of the correct methods readily available to analysts?
- Do the analysts follow the methods exactly?
- Does the laboratory require adherence to a specific control program for each sampling procedure and analytical test? (Note: specific questions about sampling, calibration, and laboratory quality control procedures are asked in Part 6, Section 6.)

Reference Methods or Approved Alternates

All methods must be Federal Register referenced methods or specific EPA approval must have been obtained for modifications or alternates.

Reagent and Media Preparation

Intent. To assess the care taken in preparation, use, and storage of reagents and microbiological culture media.

Suggested Approach

The evaluator should inspect reagent bottles and media containers for clear and complete labelling, including date of preparation (or reference to a log containing dates of preparation). Containers should be appropriate for the particular reagent or medium and should be stored under appropriate conditions (temperature, light, etc.). Questions might include:

- Is there a written schedule for preparation of fresh reagents and media? (Some must be prepared on the day of the analysis, while others may be kept for extended periods under proper conditions.)
- Are new reagent batches always checked immediately against reference standards?
- Is a record kept of reagent batches and dates used?

- Is responsibility clearly assigned for preparing and maintaining fresh supplies of reagents and media?
- Are reagents rechecked at intervals against standards for possible contamination or degradation?

PART 5. FORMS FOR ONSITE EVALUATION

The following pages contain questions that may be asked about performance of specific tests, arranged by media.

In putting this material together, we have drawn on many sources, some of which, such as the EPA form for the bacteriological survey for water laboratories, have been used successfully in practice for some time. Other parts are drawn from recent USEPA or State EPA experience wherever the material appears to have been assembled in form most closely fitting the purpose of this procedure. Although, in the following outline of this material, we have indicated the primary source from which we obtained the material, we realize that many people may have been involved and we acknowledge our debt to the many individuals and groups with whom we have held discussions during the course of this task.

Part A. Medium- Water (Chemistry). Illinois EPA, Springfield Laboratory.

Part B. Medium- Water (Bacteriology). USEPA, Water Quality Office, Water Hygiene Division, Cincinnati.

Part C. Medium- Water (Biology). USEPA Environmental Monitoring Laboratory, Cincinnati.

Part D. Medium- Air. USEPA Environmental Monitoring Laboratory, Research Triangle Park.

Part E. Medium- Pesticides. USEPA Environmental Monitoring Laboratory, Research Triangle Park

Part F. Medium- Radiation. USEPA Environmental Monitoring Laboratory, Las Vegas.

Some of the material available to us was in rough draft form and, as updated versions become available, it may be desirable to include them in this Evaluator's Guide.

PART A. MEDIUM - WATER

(CHEMISTRY)

Type of samples

Surface or ground water ________

Industrial waste ________

Domestic mixed sewage ________

Marine or estuary water ________

Sediment, sludge, or semi-solid ________

Equipment-Analytical balance-

Annual service, documented ________

Certified weights available ________

Monthly check with certified weights, documented ________

Autoclave

Checked yearly by manufacturer

with maximum registering thermometer ________

Safety valve works ________

Operating instructions posted or available ________

Deionizer

Million ohm water checked daily and documented ________

$KMnO_4$ 60 min. color retention checked daily and documented ________

Still

Checked daily and quality documented ________

Operating instructions posted or available ________

Distilled water

- Checked for copper, ammonia, and chlorine documented ________

Conductivity bridge

- Checked daily, documented ________

Double deionized water

- Available for trace analysis ________

pH meter

- Standardized for each use with buffer, documented ________
- Checked daily against second buffer for linearity, documented ________

Flouride electrode

- standardized with each use, documented ________

Colorimeter

- Calibration curves checked with at least one standard each time used ________

Drying ovens

- Temperature checked daily and recorded ________
- record indicates satisfactory operation and temperature controller functioning correctly ________

Muffle furnace pyrometer ________

Pan balances

- Clean and in servicable condition ________

  - Checked each month with two analytical balance weights ______
- Automated analyzers
  - Standard and blanks run each time ______
  - Test frequency allows instrument to return to baseline between tests ______
  - Record maintained of readings of standards for each test each time instrument is operated ______
  - Maintenance schedule followed for pump tube replacement, colorimeter cell cleaning, etc. ______
- Incubator BOD
  - Thermometer calibrated, Documented ______
  - Daily record ______
  - Uniformity of temperature check, documented ______
- Certified thermometer
  - Certification on file ______
  - Record of thermometer checks ______
- Pipette containers-
  - Alumimum or stainless steel, no copper ______

Dry heat sterilizer

Temperature documented with

recorder, charts filed ________

accuracy of recorder checked ________

Microscope

Binocular wide field ________

Fluorescent light source ________

CHEMISTRY METHODS

BOD

Dilution water checked for residual chlorine, NH_4 and Cu ______

Dilution water depletion on 5 days not more than 0.2 mg/l ______

If D.O. probe is used, calibration documented ______

If D.O. probe is used, correlation with Winkler method documented ______

Water seals on bottles protected ______

Dilutions for calculation are in the range which shows depletion of at least 2 mg/l and residual D.O. of 1 mg/l ______

Supersaturated samples deaerated before setting up ______

Chlorinated effluents checked for residual chlorine ______

Incubator temperature 20 ± 1° C documented ______

Method checked periodically by running glucose-glutamic acid standard ______

Seeding used when required On chlorinated effluents ______

On other sterile samples ______

Sodium thiosulfate stock preserved, standardized, refrigerated, and documented ______

Samples refrigerated at 4° C immediately at point of collection and delivered to lab within 12 hours ______

Analyst does not pipet samples by mouth ______

Samples pipetted by ______________________

COD - dichromate reflux method

Samples preserved by acidification, refrigeration, or both ______

Silver sulfate catalyst used ______

Mercuric sulfate used to depress chloride interference ______

Standardization of dichromate documented ______

Use boiling chips for smooth boiling ______

Daily standardization of ferrous ammonium sulfate documented ______

Sample, reagents, and sulfuric acid mixed thoroughly before heat is applied ______

Analyst uses safety glasses or eye protection ______

Analyst does not pipet sample or reagents by mouth ______

Wastes properly disposed of ______

pH - electrometric method

Instrument manufacturer's instructions available and followed ______

Instrument checked for linearity with two buffers, documented ______

Instrument standardized daily, documented ______

Calomel electrode - liquid junction functioning ______

Calomel electrode - contains at least a crystal of KC1 but not solid with KC1 ______

Electrodes rinsed between samples with distilled water and/or sample to be measured ______

Measurements made on successive portions of sample until two successive portions give equal readings ______

Sample temperature compensation applied ______

Solution pressure inside the calomel liquid junction in excess of that outside the junction ______

Immersible tips of electrodes stored in reagent water between periods of use ______

Sample agitated while making measurement ______

PART B. MEDIUM - WATER

(Bacteriological Examination)

ENVIRONMENTAL PROTECTION AGENCY
Water Quality Office
Water Hygiene Division

Bacteriological Survey for
Water Laboratories

Indicating conformity with the 13th edition of "Standard Methods for the Examination of Water and Wastewater," 1971.

Survey By	X = Deviation O = Not Used	U = Undetermined
Laboratory	Location	Date

Sampling and Monitoring Response

1. **Location and Frequency**
Representative points on system . . . . ______
Frequency of sampling adequate . . . . ______

2. **Collection Procedure**
Faucets with aerators should not be used . . . . ______
Flush tap 1 min. prior to sampling . . . . ______
Pump well 1 min. to waste prior to sampling . . . . ______
River, stream, lake, or reservior sampled at least
6 inches below surface and toward current . . . . ______
Minimum sample not less than 100 ml . . . . ______
Ample air space in bottle for mixing . . . . ______
Promptly identify sample legibly and indelibly . . . . ______

3. **Sample Bottles**
Wide mouth, glass or plastic bottles of ______ capacity . . . . ______
Sample bottles capable of sterilization and rinse . . . . ______
Closure:
a. Glass stoppered bottles protected with metal foil,
rubberized cloth or kraft type paper . . . . ______
b. Metal or plastic screw cap with leakproof liner . . . . ______
Sodium thiosulfate added for dechlorination . . . . ______
Concentration of 100 mg/l added before sterilization . . . . ______
Chelation agent for stream samples (optional) . . . . ______
Concentration 372 mg/l added before sterilization . . . . ______

4. **Transportation and Storage**
Complete and accurate data accompanies sample . . . . ______
Transit time for potable water samples should not exceed
48 hrs, preferably within 30 hrs . . . . ______
Transit time for source waters, reservoirs, and natural
bathing waters should not exceed 6 hrs . . . . ______
All samples examined within 2 hrs of arrival . . . .
Sample refrigeration mandatory on stream samples,
optional on potable water samples . . . . ______

5. **Record of Laboratory Examination**
Results assembled and available for inspection . . . . ______
Number of tests per year . . . . ______

Laboratory	**Location**	**Date**

5. **Record of Laboratory Examination (Continued)**
MPN Test - Type of sample ________________
Confirmed (+)________(-)________(Total)________
Completed (+)________(-)________(Total)________
MF Test - Type of sample ________________
Direct Count (+)________(-)________(Total)________
Verified Count (+)________(-)________(Total)________
Data processed rapidly through laboratory and engineering sections . . . . ________
Unsatisfactory sample defined as 3 or more positive tubes per MPN test or 5 or more colonies per 100 ml in MF test . . . . ________
High priority placed on alerting operator to unsatisfactory potable water results . . . . ________
Prompt resampling for unsatisfactory samples . . . . ________

6. **Laboratory Evaluation Service**
State program to evaluate all laboratories which examine potable water supplies . . . . ________
Frequency of surveys on a ________ year basis . . . . ________
State survey officer (name)________________________ . . . . ________
Status of laboratory evaluation services . . . . ________
Total ________ labs known to examine water
________ approved laboratories
________ provisional laboratories

Laboratory Apparatus

7. **Incubator**
Manufacturer ________________ Model ________________
Sufficient size for daily work load . . . . ________
Maintain uniform temperature in all parts (± 0.5° C) . . . . ________
Accurate thermometer with bulb immersed in liquid on top and bottom shelves . . . . ________
Daily record of temperature or use of recording thermometer sensitive to 0.5° C change . . . . ________
Incubator not subject to excessive room temperature variations beyond a range of 50 - 80° F . . . . ________

8. **Incubator Room (Optional) Manufacturer**
Well insulated, equipped with properly distributed heating and humidifying units for optimum enviornmental control . . . . ________
Shelf areas used for incubation must conform to 35° C ± 0.5° temperature requirement . . . . ________
Accurate thermometers with bulb immersed in liquid . . . . ________
Daily record of temperature at selected areas or use recording thermometer sensitive to 0.5° C changes . . . . ________

9. **Water Bath**
Manufacturer ________________ Model ________________
Sufficient size for fecal coliform tests . . . . ________
Maintain uniform temperature 44.5° C ± 0.2° C . . . . ________
Accurate thermometer immersed in water bath . . . . ________
Daily record of temperature or use of recording thermometer sensitive to 0.2° C changes . . . . ________

Laboratory	Location	Date

10. **Hot Air Sterilizing Oven**
Manufacturer ____________________ Model ____________________
Size sufficient to prevent crowding of interior . . . . ________
Constructed to insure a stable sterilizing temperature . . . . ________
Equipped with accurate thermometer in range of 160 - 180° C
or with recording thermometer . . . . ________

11. **Autoclave**
Manufacturer ____________________ Model ____________________
Size sufficient to prevent crowding of interior . . . . ________
Constructed to provide uniform temperature up to and
including 121° C . . . . ________
Equipped with accurate thermometer with bulb properly located
to register minimal temperature within chamber . . . . ________
Pressure gage and operational safety valve . . . . ________
Steam source from saturated steam line, or from gas or
electrically heated steam generator . . . . ________
Reach sterilization temperature in 30 min. . . . . ________
Pressure cooker may be used only if provided with a pressure
gage and thermometer with bulb 1 inch above water level . . . . ________

12. **Thermometers**
Accuracy checked with thermometer certified by National
Bureau of Standards or one of equivalent accuracy . . . . ________
Liquid column free of discontinuous sections and graduation
marks legible . . . . ________

13. **pH Meter**
Manufactuer ____________________ Model ____________________
Electronic pH meter accurate to 0.1 pH units . . . . ________

14. **Balance**
Balance with 2 g sensitivity at 150 g load used for general
media preparations, Type ____________ . . . . ________
Analytical balance with 1 mg sensitivity at 10 g load used
for weighing quantities less than 2 g, Type ____________ . . . . ________
Appropriate weights of good quality for each balance . . . . ________

15. **Microscope and Lamp**
Preferably binocular wide field, 10 to 15 diameters magnification for MF colony counts, Type ____________ . . . . ________
Fluorescent light source for sheen discernment . . . . ________

16. **Colony Count**
Quebec colony counter, dark-field model preferred for
standard plate counts . . . . ________

17. **Inoculating Equipment**
Wire loop of 22 or 24 gauge chromel, nichrome, or platinum
iridium, sterilized by flame . . . . ________
Single-service transfer loops of aluminum or stainless steel, presterilized by dry heat or steam . . . . ________
Disposable single service hardwood applicators, presterilized by dry heat only . . . . ________

18. **Membrane Filtration Units**
Manufacturer ____________________ Type ____________________
Leakproof during filtration . . . . ________
Metal plating not worn to expose base metal . . . . ________

Laboratory	Location	Date

19. Membrane Filters

Manufacturer ____________ Type ____________

Full bacterial retention, satisfactory filtration speed . . . . ________

Stable in use, glycerin free . . . . ________

Grid marked with non-toxic ink . . . . ________

Presterilized or autoclaved 121° C for 10 min. . . . . ________

20. Absorbent Pads

Manufacturer ____________ Type ____________

Filter paper free from growth inhibitory substances . . . . ________

Thickness uniform to permit 1.8 - 2.2 ml medium absorption . . . . . . ________

Presterilized or autoclaved with membrane filters . . . . ________

21. Forceps

Preferably round tip without corrugations . . . . ________

Forceps are alcohol flamed for use in MF procedure . . . . ________

Glassware, Metal Utensils and Plastic Items

22. Media Preparation Utensils

Borosilicate glass . . . . ________

Stainless steel . . . . ________

Utensils clean and free from foreign residues or dried medium . . . . ________

23. Pipettes

Brand ____________ Type ____________

Calibration error not exceeding 2.5% . . . . ________

Tips unbroken, graduation distinctly marked . . . . ________

Deliver accurately and quickly . . . . ________

Mouth end plugged with cotton (optional) . . . . ________

24. Pipette Containers

Box, aluminum or stainless steel . . . . ________

Paper wrapping of good quality sulfite paper (optional) . . . . ________

25. Petri Dishes

Brand ____________ Type ____________

Use 100 mm x 15 mm dishes for pour plates . . . . ________

Use 60 mm x 15 mm dishes for MF cultures . . . . ________

Clear, flat bottom, free from bubbles and scratches . . . .

Plastic dishes may be reused if sterilized in 70% ethanol for 30 min. or by ultraviolet radiation . . . . ________

26. Petri Dish Containers

Aluminum or stainless steel cans with covers, coarsely woven wire baskets, char-resistant paper sacks or wrappings . . . . ________

27. Culture Tubes

Size sufficient for total volume of medium and sample portions . . . . . . ________

Borosilicate glass or other corrosive resistant glass . . . . ________

28. Dilution Bottles or Tubes

Borosilicate or other corrosive resistant glass . . . . ________

Screw cap with leakproof liner free from toxic substances on sterilization . . . . ________

Graduation level indelibly marked on side of bottle or tube . . . . ________

Laboratory	**Location**	**Date**

Materials and Media Preparation

29. Cleaning Glassware

Dishwasher manufacturer __________ Model __________

Thoroughly washed in detergent at 160° F, cycle time ______ . . . . . . ______

Rinse in clean water at 180° F, cycle time ______ . . . . ______

Final rinse in distilled water, cycle time ______ . . . . ______

Detergent brand __________ . . . . ______

Washing procedure leaves no toxic residue . . . . ______

Glassware free from acidity or alkalinity . . . . ______

30. Sterilization of Materials

Dry heat sterilization (1 hr at 170° C)

Glassware not in metal containers . . . . ______

Dry heat sterilization (2 hrs at 170° C)

Glassware in metal containers . . . . ______

Glass sample bottles . . . . ______

Autoclaving at 121° C for 15 min. . . . . ______

Plastic sample bottles . . . . ______

Dilution water blanks . . . . ______

31. Laboratory Water Quality

Still manufacturer __________ Construction material __________

Demineralizer with __________ recharge frequency

Protected storage tank . . . . ______

Supply adequate for all laboratory needs . . . . ______

Free from traces of dissolved metals or chlorine . . . . ______

Free from bactericidal compounds as measured by bacteriological suitability test . . . . ______

Bacteriological quality of water measured once each year by suitability test or sooner if necessary . . . . ______

32. Buffered Dilution Water

Stock phosphate buffer solution pH 7.2 . . . . ______

Prepare fresh stock buffer when turbidity appears . . . . ______

Stock buffer autoclaved and stored at 5 - 10° C . . . . ______

1.25 ml stock buffer per 1 liter distilled water . . . . ______

Dispense to give 99 ± 2 ml or 9 ± 0.2 ml after autoclaving . . . . ______

33. pH Measurements

Calibrate pH meter against appropriate standard buffer prior to use . . . . ______

Standard buffer brand __________ pH __________

Check the pH of each sterile medium batch or at least one batch from each new medium lot number . . . . ______

Maintain a pH record of each sterile medium batch, the date and lot number . . . . ______

34. Sterilization of Media

Carbohydrate medium sterilized 121° C for 12 min. . . . . ______

All other media autoclaved 121° C for 15 min. . . . . ______

Tubes packed loosely in baskets for uniform heating and cooling . . . . ______

Timing starts when autoclave reaches 121° C . . . . ______

Total exposure of carbohydrate media to heat not over 45 min. . . . . . . ______

Media removed and cooled as soon as possible after sterilization . . . . . . ______

Laboratory	**Location**	**Date**

35. **Storage**
Dehydrated media bottles kept tightly closed and stored at less than 30° C . . . . ______
Dehydrated media not used if discolored or caked . . . . ______
Sterile culture media stored in clean area free from contamination and excessive evaporation . . . . ______
Sterile batches used in less than 1 week . . . . ______
All media protected from sunlight . . . . ______
If media is stored at low temperatures, it must be incubated overnight and any tubes with air bubbles discarded . . . . ______

Culture Media - Specifications

36. **Lactose Broth**
Manufacturer ____________ Lot No. ____________
Single strength composition 13 g per liter distilled water. . . . . ______
Single strength pH 6.9 ± 0.1, double strength pH 6.7 ± 0.1 . . . . ______
Not less than 10 ml medium per tube . . . . ______
Composition of medium after 10 ml sample is added must contain 0.013 g per ml dry ingredients . . . . ______

37. **Lauryl Tryptose Broth**
Manufacturer ____________ Lot No. ____________
Single strength composition 35.6 g per liter distilled water . . . . ______
Single strength pH 6.8 ± 0.1, double strength pH 6.7 ± 0.1 . . . . ______
Not less than 10 ml medium per tube . . . . ______
Composition of medium after 10 ml sample is added must contain 0.0356 g per ml of dry ingredients . . . . ______

38. **Brilliant Green Lactose Bile Broth**
Manufacturer ____________ Lot No. ____________
Correct composition, sterility and pH 7.2 . . . . ______
Not less than 10 ml medium per tube . . . . ______

39. **Eosin Methylene Blue Agar**
Manufacturer ____________ Lot No. ____________
Medium contains no sucrose, Cat. No. ____________
Correct composition, sterility and pH 7.1 . . . . ______

40. **Plate Count Agar (Tryptose Glucose Yeast Agar)**
Manufacturer ____________ Lot No. ____________
Correct composition, sterility and pH 7.0 ± 0.1 . . . . ______
Free from precipitate . . . . ______
Sterile medium not remelted a second time after sterilization . . . . . . ______

41. **EC Medium**
Manufacturer ____________ Lot No. ____________
Correct composition, sterility and pH 6.9 . . . . ______
Not less than 10 ml medium per tube . . . . ______

42. **M-Endo Medium**
Manufacturer ____________ Lot No. ____________
Correct composition and pH 7.1 - 7.3 . . . . ______
Reconstituted in distilled water containing 2% ethanol . . . . ______
Heat to boiling point, promptly remove and cool . . . . ______
Store in dark at 2 - 10° C . . . . ______
Unused medium discarded after 96 hrs . . . . ______

Laboratory	Location	Date

43. **M-FC Broth**

Manufacturer ____________ Lot No. ____________

Correct composition and pH 7.4 . . . . ______

Reconstituted in 100 ml distilled water containing 1 ml of a 1% rosolic acid reagent . . . . ______

Stock solution of rosolic acid discarded after 2 weeks or when red color changes to muddy brown . . . . ______

Heat to boiling point, promptly remove and cool . . . . ______

Store in dark at 2 - 10° C . . . . ______

Unused medium discarded after 96 hrs . . . . ______

44. ____________ Broth

Manufacturer ____________ Lot. No. ____________

Correct composition and pH . . . . ______

45. ____________ Agar

Manufacturer ____________ Lot No. ____________

Correct composition and pH . . . . ______

Multiple Tube Coliform Test

46. **Presumptive Procedure**

Lactose broth ____________ lauryl tryptose broth ____________

Shake sample vigorously . . . . ______

Potable water: 5 standard portions, either 10 or 100 ml . . . . ______

Stream monitoring: multiple dilutions . . . . ______

Incubate tubes at 35° ± 0.5° C for 24 ± 2 hrs . . . . ______

Examine for gas ______ any gas bubble positive . . . . ______

Return negative tubes to incubator . . . . ______

Examine for gas at 48 ± 3 hr from original incubation . . . . ______

47. **Confirmed Test**

Promptly submit all presumptive tubes showing gas production before or at 24 hr and 48 hr periods to confirmed test . . . . ______

a. Brilliant green lactose broth

Gently shake presumptive tube or mix by rotating . . . . ______

Transfer one loopful of positive broth or one dip of applicator . . . ______ from presumptive tube to brilliant green lactose broth . . . . . . ______

Incubate at 35° ± 0.5° C and check at 24 hrs for gas production . . ______

Reincubate negative tubes for additional 24 hrs and check for gas production . . . . ______

Calculate MPN or report positive tube results . . . . ______

b. Endo or eosin methylene blue agar plates adequate streaking to obtain discrete colonies separated by 0.5 cm . . . . ______

Incubate at 35° ± 0.5° C for 24 ± 2 hrs . . . . ______

Typical nucleated colonies with or without sheen are coliforms . . . ______

If atypical unnucleated pink colonies develop, result is doubtful and completed test must be applied . . . . ______

If no colonies or only colorless colonies appear, the confirmed test is negative . . . . ______

48. **Completed Test**

Applied to all potable water samples or a proportion each three months to establish the validity of the confirmed test in determining their sanitary quality . . . . ______

Laboratory	Location	Date

48. Completed Test (Continued)

Applied to positive confirmed tubes or to doubtful colonies on differential medium . . . . ________

Streak positive confirmed tubes on Endo or EMB plates for colony isolation . . . . ________

Choice of selected isolated colony for verification should be one typical or two atypical to lactose or lauryl tryptose broth and to agar slant for gram stain . . . . ________

Incubate at 35° C ± 0.5° C for 24 hrs or 48 hrs . . . . ________

Gram negative rods without spores and gas in lactose tube with 48 hrs in positive completed test . . . . ________

Membrane Filter Coliform Test

49. Application as Standard Test

Use as a standard test for determining potability of water after demonstration by parallel testing that it yields information equal to that from the multiple-tube fermentation procedure . . . . . . ________

50. MF Procedure

Filter funnel and receptacle sterile at start of series . . . . ________

Rapid funnel resterilization by UV, flowing steam or boiling water acceptable . . . . ________

Membrane filter cultures and technician eyes should not be subject to UV radiation leaks . . . . ________

Filtration volume not less than 50 ml for potables water; multiple dilutions for stream pollution . . . . ________

Rinse funnel by flushing several 20 - 30 ml portions of sterile buffered water through MF . . . . ________

Remove filter with sterile forceps . . . . ________

Roll filter over M-Endo medium pad or agar so air bubbles will not form . . . . ________

51. Incubation

In high humidity or in tight fitting culture dishes . . . . ________

At 35° C ± 0.5° C for 22 - 24 hrs . . . . ________

52. Counting

All colonies with a metallic yellowish green surface sheen . . . . ________

If coliforms are found in potable samples, verify by transfers to lactose broth, then to BGB broth for evidence of gas production at 35° C within 48 hr limit . . . . ________

Calculate direct count in coliform density per 100 ml . . . . ________

53. Standard MR Test with Enrichment

Incubate MF after filtration on pad saturated with lauryl tryptose broth for 1 1/2 - 2 hrs at 35° C ± 0.5° C . . . . ________

Transfer MF culture to M-Endo medium for a final 20 - 22 hr incubation at 35° C ± 0.5° C . . . . ________

Count sheen colonies, verify if necessary, and calculate direct count in coliform density per 100 ml . . . . ________

Supplementary Bacteriological Methods

54. Standard Plate Count

Plate not more than 1 or less than 0.1 ml (sample or dilution) . . . . ________

Add 10 ml or more liquified agar medium at a temperature between 43 - 45° C . . . . ________

Laboratory	Location	Date

54. **Standard Plate Count (Continued)**

Melted medium stored for no more than 3 hrs at 43 - 45° C . . . . ________

Liquid agar and sample portion thoroughly mixed by gently rotating to spread mixture evenly . . . . ________

Count only plates with between 30 and 300 colonies, exception being 1 ml sample with less than 30 colonies . . . . ________

Record only two significant figures and calculate as "standard plate count at 35° C per 1 ml of sample" . . . . ________

55. **Fecal Coliform Test**

a. Multiple Tube Procedure

Applied as an EC broth confirmation of all positive presumptive tubes . . . . ________

Place EC tubes in water bath within 30 min. of transfers . . . . . . ________

Incubate at 44.5° C ± 0.2° C for 24 hrs . . . . ________

Gas production is positive test for fecal coliforms . . . . ________

Calculate MPN based on combination of positive EC tubes . . . . . ________

b. Membrane Filter Procedure

Following filtration place MF over pad saturated with M-FC broth . . . . ________

Place MF cultures in waterproof plastic bag and submerge in water bath within 30 min. . . . . ________

Incubate at 44.5° C ± 0.2° C for 24 hrs . . . . ________

All blue colonies ar fecal coliforms . . . . ________

Calculate direct count in density per 100 ml . . . . ________

56. **Delayed-Icubation Coliform Test**

After filtration, place MF over pad of M-Endo containing 3.2 ml of a 12% sodium benzoate solution per 100 ml of medium . . . . ________

Addition of 50 mg cycloheximide per 100 ml of preservative medium for fungus suppression is optional . . . . ________

Transport culture by mail service to laboratory within 72 hrs . . . . ________

Transfer MF cultures to standard M-Endo medium at laboratory . . . . ________

Incubate at 35° C ± 0.5° C for 20 - 22 hrs . . . . ________

If at time of transfer growth is visible, hold in refrigerator till end of work day then incubate at 35° C overnight ________
(16 - 18 hr period) . . . . ________

Count sheen colonies, verify if necessary, and calculate direct count in coliform density per 100 ml . . . . ________

57. **Additional Test Capabilities**

Fecal streptococci ________________ Method ________________
Pseudomonas aeruginosa ________________ Method ________________
Staphylococcus ________________ Method ________________
Salmonellae ________________ Method ________________
Biochemical tests ________________ Purpose ________________
Serological tests ________________ Purpose ________________
Other ________________ Purpose ________________

Laboratory	Location	Date

Laboratory Staff and Facilities

58. **Personnel**

Adequately trained or supervised for bacteriological examination of water . . . . ______

Laboratory staff ______ (Total) Prep room staff ______ (Total)

59. **Reference Material**

Copy of the current edition of Standard Methods available in the laboratory . . . . ______

State or federal manuals on bacteriological procedures for water available for staff use . . . . ______

60. **Physical Facilities**

Bench-top area adequate for periods of peak work in processing samples . . . . ______

Sufficient cabinet space for media and chemical storage . . . . ______

Office space and equipment available for processing water examination reports and mailing sample bottles . . . . ______

Facilities clean, with adequate lighting, ventilation and reasonably free from dust and drafts . . . . ______

61. **Laboratory Safety**

Proper receptacles for contaminated glassware and pipettes . . . . ______

Adequately functioning autoclaves with periodic inspection and maintenance . . . . ______

Accessible facilities for hand washing . . . . ______

Proper maintenance of electrical equipment to prevent fire and electrical shock . . . . ______

Convenient gas and electric outlets . . . . ______

First aid supplies available and not out-dated . . . . ______

62. **Remarks**

PART C. MEDIUM-WATER BIOLOGY

BIOLOGICAL FIELD EQUIPMENT

A. Mobile Labs
1. Number available (____)

(Check)
2. Equipped for:
____ a. Static bioassay
____ b. Flow-through bioassay
____ c. Fish bioassay
____ d. Macroinvertebrate bioassays
____ e. Algal assay

B. Boat and Motors

Type	Age	Condition	Hull	Length	Beam	HP	Floatation	
							Integral	Other
1.								
2.								
3.								
4.								
5.								

C. Scuba Gear

General description of available gear.

D. Sampling Equipment
1. Plankton
a. Water Bottles

	Metallic	Plastic	Volume (liters)
(1) Kemmerer			
(a)			
(b)			
(c)			
(2) Van Dorn			
(a)			
(b)			
(c)			

____ b. Pump sampler
____ c. Integrated (Tubular) sampler
____ d. Plankton Net
Wisconsin type (net mesh size ______)
Clark-Bumbus type (net mesh size______)

BIOLOGICAL FIELD EQUIPMENT

D. Sampling Equipment (Continued)

2. Periphyton
   - a. Substrate type
     - ___ (1) Glass
     - ___ (2) Plexiglass
     - ___ (3) Other (specify) ______________
   - b. Substrate dimensions ______ cm X ______ cm
   - c. Substrate exposure depth, ______ cm
   - d. Substrate Orientation
     - (1) Vertical
     - (2) Horizontal

3. Macrophyton:

   Specify:

4. Macroinvertebrates:

   a. Grabs

Type	Area of bite (m^2)			
	.0232	.0523	.0929	Other
Ponar				
Petersen				
Ekman				
Tall Ekman				
Other (specify)				

   b. Corers

   Specify:

BIOLOGICAL FIELD EQUIPMENT

D. Sampling Equipment (Continued)

4. Macroinvertebrates (Continued)
   - c. Artificial Substrates
     - (1) Multiplate
     - ____ (2) Masonite
     - ____ (3) Other (Specify) ____________
   - d. Basket
     - ____ (1) Limestone
     - ____ (2) Other (Specify) ____________
   - ____ e. Surber sampler
   - f. Other samplers
   - g. Sieves
     - (1) #30 Standard
     - (2) #40 Standard
     - (3) ____________(Other)

5. Fish
   - a. Shocker
     - ____ (1) AC
     - ____ (2) DC
     - (3) Operating voltage ____________
     - (4) Manufacturer ____________
   - b. Gill nets

	Mesh size (cm)	Length (m)
(1)		
(2)		
(3)		
(4)		

BIOLOGICAL FIELD EQUIPMENT

c. Trammel nets

	Mesh size (cm)	Length (m)
(1)		
(2)		
(3)		
(4)		

d. Seines

	Mesh size (cm)	Length (m)
(1)		
(2)		
(3)		
(4)		

e. Trawls
(1) Specify ____________________

E. Miscellaneous

Instrument	Manufacturer	Type/Model	Age	Condition
1. Submarine Photometer				
2. Current meter				
3. Secchi measurement				
4. Benthic respirometer				
5. Secchi disk				

BIOLOGICAL LABORATORY EQUIPMENT

A. Counting and Identification

1. Microscopes

	Age/ Cond.	Manuf.	Ocular(s) Magnif.(X)	Objectives				Phase	Nomarski	Equipped for photomicrogr.	Whipple
				X	X	X	X				
a. Compound, monocular (1)											
(2)											
(3)											
b. Compound, binocular (1)											
(2)											
(3)											
c. Portable field microscope											
d. Stereo (dissection) microscope				Magnification range							
(1) Rotating nosepiece (a)								▨	▨		
(b)								▨	▨		
(c)								▨	▨		
(2) Zoom (a)								▨	▨		
(b)								▨	▨		
(c)								▨	▨		

BIOLOGICAL LABORATORY EQUIPMENT

B. Biomass Determination

1. Balance	No. Avail.	Make	Type/Model Size, etc.	Age	Condition
a. ________					
b. ________					
c.					
2. Drying oven					
3. Vacuum oven					
4. Muffle furnace					
Temp. control (?) ________					
5. Desiccators					
6. ATP measuring instruments					
a. ________					
b.					
7. Centrifuge ________					
Refrigerated (?) ________					
8. Freeze drier					

BIOLOGICAL LABORATORY EQUIPMENT

C. Chlorophyll Measurements

Instrument	No. Avail.	Make	Type/Model Size, etc.	Age	Condition
1. Spectrophotometer a.					
b.					
c.					
2. Fluorometer a.					
b.					
c.					
(List excitation and emission filters for fluorometers)					
3. Tissue grinder					
4. Sonifier					

D. Culturing and Rearing Equipment

1. Algal culture chamber
2. Macroinvertebrate
3. Fish

BIOLOGICAL LABORATORY EQUIPMENT

E. Bioassay Facilities

1. Algal Assay - (Describe briefly)

2. Macroinvertebrate bioassay - (Describe briefly)

3. Fish bioassay

   a. Static bioassay - (Briefly describe size and number of dilution water supply chambers, number of replicates, number of tests that can be run simultaneously, temperature control, and other supporting equipment.)

   b. Flow-through - (Briefly describe size and number of chambers, dilution water supply, temperature control, diluters, etc.)

BIOLOGICAL SAMPLE ANALYSIS

(Work load and methodology)

Type of Analysis	No. Samples/ yr.	Methodology			Comments
		EPA	Stand. Methods	Other	
A. Plankton					
1. Phytoplankton count & identification					
2. Diatom species proportional count					
3. Zooplankton count and identification					
4. Ash-free weight					
5. Chlorophyll determination					
6. ATP determination					
7. Primary productivity, oxygen method					
8. Primary productivity, carbon-14 method					
9. Algal assay					
B. Periphyton					
1. Cell counts and identification					
2. Diatom species proportional counts					
3. Ash-free weight					
4. Chlorophyll determinations					
5. ATP determination					

Type of Analysis	No. Samples/ yr.	Metholology			Comments
		EPA	Stand. Methods	Other	
C. Macrophyton					
1. Identification					
2. Ash-free weight					
3. Chlorophyll					
D. Macroinvertebrates					
1. Counts and Identification					
2. Ash-free weight					
3. Flesh tainting					
4. Tissue analysis					
5. Bioassay, static					
6. Bioassay, flow-through					
E. Fish					
1. Counts/ID/wgt/lgth					
2. Flesh tainting					
3. Tissue analysis					
4. Bioassay, static					
5. Bioassay, flow-through					

LIST OF BIOLOGICAL PROCEDURES

A. Phytoplankton
(Check) 1. Sample Volume ______ (liters)
2. Preservative
______ a. Formalin
______ b. Merthiolate
______ c. Other (specify) ______________
3. Counting Techniques used
______ a. Sedgwick-Rafter Cell
______ b. Palmer-Maloney Cell
______ c. Membrane Filter Counts
______ d. Inverted Microscope Method
______ e. Other (specify)
4. Counting units used
______ a. Natural Unit (clump count)
______ b. Areal Unit
______ c. Cell count
______ d. Cell volume
5. Identification Level
a. Total phytoplankton count
______ (1) Identify to genus
______ (2) Identify to species
______ (3) Identify to major groups only
______ b. Diatom species proportional count
6. Biomass measurements
______ a. Dry weight
______ b. Ash-free weight
______ c. ATP
______ d. DNA
______ e. Chlorophyll
(1) Solvent used ______________
______ (2) Fluorometric, in vivo method
______ (3) Fluorometric, in vitro method
______ (4) Fluorometric, in pheophytin correction
______ (5) Spectrophotometric, Trichromatic, Strickland/Parsons
______ (6) Spectrophotometric, Trichromatic, SCOR/UNESCO
______ (7) Spectrophotometric, pheophytin correction
7. Metabolic Rates
______ a. Productivity, oxygen method
______ b. Productivity, Carbon-14 method
______ c. Nitrogen fixation, acetylene reduction
8. Algal Assay
______ a. Trophic level (biostimulation test)
______ b. Limiting nutrient test
______ c. Toxicity test
______ d. Bottle method
______ e. Flow-through method

LIST OF BIOLOGICAL PROCEDURES (2)

B. Periphyton
(Check) 1. Sample area ________ mm^2
2. Preservative
______ a. Formalin
______ b. Merthiolate
______ c. Other (specify) ______________
3. Counting Techniques used
______ a. Sedgwick-Rafter Cell
______ b. Palmer-Maloney Cell
______ c. Membrane Filter Counts
______ d. Inverted Microscope Method
______ e. Other (specify)
4. Counting units used
______ a. Natural Unit (clump count)
______ b. Areal Unit
______ c. Cell count
______ d. Cell volume
5. Identification Level
a. Total phytoplankton count
______ (1) Identify to genus
______ (2) Identify to species
______ (3) Identify to major groups only
______ b. Diatom species proportional count
6. Biomass measurements
______ a. Dry weight
______ b. Ash-free weight
______ c. ATP
______ d. DNA
______ e. Chlorophyll
(1) Solvent used ________________
______ (2) Fluorometric, in vivo method
______ (3) Fluorometric, in vitro method
______ (4) Fluorometric, pheophytin correction
______ (5) Spectrophotometric, Trichromatic, Strickland/Parsons
______ (6) Spectrophotometric, Trichromatic, SCOR/UNESCO
______ (7) Spectrophotometric, pheophytin correction
7. Metabolic Rates
______ a. Productivity, oxygen method
______ b. Productivity, Carbon-14 method
______ c. Nitrogen fixation, acetylene reduction
8. Bioassay
______ a. Trophic level (biostimulation test)
______ b. Limiting nutrient test
______ c. Toxicity test
______ d. Bottle method
______ e. Flow-through method

LIST OF BIOLOGICAL PROCEDURES (3)

C. Macroinvertebrates

(Check)

1. Sample preservation
   - ______ a. Formalin ______%
   - ______ b. Ethanol ______%
   - ______ c. Other (specify) ______________
2. Sieve employed
   - ______ a. Standard #30
   - ______ b. Standard #40
   - ______ c. Other (specify)
3. Sorting techniques
   - ______ a. Stain with Rose bengal
   - ______ b. Fluorescent stain
   - ______ c. Other stain (specify) ______________
   - ______ d. Sugar floatation
   - ______ e. Other separation method (specify) ______________
4. Identification

(Check)

Group	Level of Identification			
	Order	Family	Genus	Species
a. Diptera (excl. midges)				
b. Midges				
c. Trichoptera				
d. Plecoptera				
e. Ephemeroptera				
f. Odonata				
g. Neuroptera				
h. Hemiptera				
i. Crustacea				
j. Hirudinea				
k. Nematoda				
l. Bivalvia				
m. Gastropoda				

______ 5. Maintain reference collection of organisms for identification

______ 6. Use "outside" consultants for difficult identifications

______ 7. Rear larvae to adult stage to aid in identifications

______ 8. Tissue analysis for toxic substances

9. Bioassay
   - ______ a. Static
   - ______ b. Flow-through

LIST OF BIOLOGICAL PROCEDURES (4)

D. Fish

(Check) 1. Preservative

_____ a. Formalin

_____ b. Other (specify) ____________________

2. Age determinations

_____ a. Scales

_____ b. Other (specify)

_____ 3. Condition factor (length-weight relationship)

_____ 4. Flesh tainting

_____ 5. Histopathological studies (describe):

6. Bioassays

a. Laboratory

_____ (1) Static tests (describe):

_____ (2) Flow-through tests (describe):

_____ b. In-situ tests (describe):

PART D. MEDIUM AIR

MANUAL - SO_2 or NO_2

Sampling

Volume (No. of Samples)

Method of Delivery (Field to Lab)

Sampler Used

Frits-Impingers

Time Between Sampling and Analysis

Storage Method

Analysis

Method

Copy Available

Calculations

Equipment (Automated-Manual)

Preventive Maintenance	Items		Schedule
Chemical Purity of Reagents	Reagents	or	Gases

Reagent Makeup Procedure

Reagent Standardization Procedure

Calibration

Procedure (Samplers)

Procedure (Analysis)

Copies Available

Frequency

Curves Available

Calibration History

MANUAL - SO_2 or NO_2 (Continued)

Data Processing

Mode Utilized ____________________
(Strip Chart, Mag. Tape)

Discrepancies ____________________

SAROAD Format ____________________

Reduction Procedure ____________________

Reporting of Data ____________________

Continuous SO_2, NO_2, CO, or O_3

Type of Analyzers ______________________________

No. of Analyzers ______________________________

No. of Field Stations ______________________________
Containing Analyzers

Frequency of Sampling ______________________________

Manpower (Attended-Unattended) ______________________________

Frequency of Calibration ______________________________

Method of Calibration ______________________________

Traceability of Calibration ______________________________

Curves Available ______________________________

Documentation ______________________________

Frequency of Zero and Span ______________________________

Corrective Action Plan ______________________________
If Out of Specs

Maintenance Log ______________________________

Data Collection Device ______________________________
(Strip Chart, Mag. Tape)

Data Reduction ______________________________

Reports ______________________________

MANUAL - HI VOL

Type

No. of Analyzers

No. of Sites

Frequency

Type of Filter

Pre-exposure Checks and Procedures

Collection Procedures

Calibrating Procedures

Weighing Procedures

Frequency

Data Handling

PART E. MEDIUM - PESTICIDES

The following questions may be asked *in toto* if the personnel do not seem to know much about gas chromatography. If personnel seem versed in GLC, it may be necessary only to pick out some questions in each subsection.

I. GLC Calibration & Maintenance

A. Detector (EC)

1. Frequency of preparation of linearity curves for pesticides of interest - weekly ☐ monthly ☐ never ☐ ______
2. Frequency of determination of standing current profile - weekly ☐ monthly ☐ never ☐ other ☐ (describe) ______
3. Frequency of construction of voltage/response curve - weekly ☐ monthly ☐ never ☐ other ☐ (describe) ______
4. Comments on method of selection of optimum polarizing voltage. ______

B. Detector (FPD)

1. Date unit purchased ______.
2. Manufacturer of power supply unit ______
3. Voltage applied to photomultiplier tube ______ volt. Awareness of operator ______
4. Has a determination been made of the signal to noise ratio as a criterion for optimal selection? Yes ☐ No ☐ Comments: ______
5. Have heat shields and filters been checked on a spectrophotometer for light transmission at specified wavelengths? Yes ☐ No ☐ If yes, at what wavelengths?
   - P (526 mu) Actual %T ______
   - S (394 mu) Actual %T ______
6. Have velocity of gases been adjusted to give optimum signal to noise ratio? Yes ☐ No ☐ If yes, provide gas flows in ml/min. H_2 ______, O_2 ______, Air ______
7. Date detector last cleaned? ______ O-rings changed? ______
8. Sensitivity in terms of % F.S.D. for 2.5 ng of ethylparathion. ______
9. Baseline noise ______ % F.S.D.
10. Is flame extinguished overnight? Yes ☐ No ☐
11. Does instrument have vent valve? Yes ☐ No ☐ If no, how is flame-out avoided? ______

C. Alkaline Flame Detector

1. Which salt is used? ______
2. Is flame extinguished overnight? Yes ☐ No ☐
3. Give frequency of cleaning of loop collector to detector ______
4. If electrical current to collector loop is supplied by batteries, give frequency of battery changing or recharging ______
5. Give operating baseline current ______ amps.
6. Baseline noise ______ % F.S.D.
7. Give sensitivity in terms of % F.S.D. from 2.5 ng ethylparathion. ______

D. Flame Ionization Detector

1. Give frequency of cleaning of collector loop ______________________________
2. If electrical current to collector loop is supplied by batteries, give frequency of battery changing or recharging ______________________________
3. Give operating baseline current __________ amps.

E. Coulson Electrolytic Conductivity Detector

1. Date of purchase ______________________________
2. Mode of operation ______________________________
3. Sensitivity in terms of % F.S.D. resulting from 1 ng of aldrin ______________________________ ______________________________
4. Normal baseline noise __________ % F.S.D.
5. Pyrolysis furnace temperature __________ °C.
6. Block temperature __________ °C.
7. Flow rates in m1/min. of purge and carrier gas ______________________________
8. Flow rates in m1/min. of Q_2 or H_2 ______________________________
9. Pretreatment of water used in cell ______________________________ ______________________________
10. Flow velocity of water through pressure control tube __________ ml/min.
11. Flow velocity of water through syphon arm of cell __________ ml/min.
12. Identity of GLC column(s) used ______________________________ ______________________________

F. Electrometers

1. Frequency of zeroing daily ☐ weekly ☐ monthly ☐ never ☐ other ☐ (describe) ______________________________
2. Frequency of determination of attenuator linearity daily ☐ weekly ☐ monthly ☐ never ☐ other ☐ (describe) ______________________________ ______________________________
3. Frequency of repair ______________________________

G. Strip Chart Recorders

1. Frequency of zeroing baseline daily ☐ weekly ☐ monthly ☐ never ☐ other ☐ (describe) ______________________________ ______________________________
2. Describe method of determining optimum gain control setting ______________________________ ______________________________
3. Frequency of cleaning of slide wire ______________________________

H. GLC Columns

1. Is column efficiency determined before routine use? Yes ☐ No ☐ If yes, describe method ______________________________
2. Are response characteristics determined before use? Yes ☐ No ☐ If yes, describe method ______________________________
3. Frequency of changing demister tube, if used ______________________________ ______________________________
4. Frequency of changing glass wool plug at column inlet ______________________________ ______________________________
5. Is any determination made of compound degradation characteristics of column-endrin, p.p'-DDT? ______________________________
6. If column used for FPD, are response characteristics determined prior to use? Yes ☐ No ☐ If answer is yes, describe method. ______________________________ ______________________________
7. In using the column for tentative identification of peaks, are RRT_A or EP data utilized? Yes ☐ No ☐ If answer is no, describe the alternative used. ______________________________ ______________________________

I. GLC Operation - General

1. Is any method used to monitor accuracy of instrument pyrometer? Yes ☐ No ☐ If answer is yes, describe. ____________________
____

2. Is carrier flow velocity monitored by bubble meter? Yes ☐ No ☐ If answer is no, request operator to set what he thinks is 70 ml/min. and make actual check with bubble meter.
____

3. Assessment of flow system plumbing - molecular sieve filter, neatness of layout, knowledge of operator pertinent to checking for leaks, etc. ____________________
____

4. Is a log maintained for each instrument showing chronological data such as change of detector, etc. ____________________
____

5. General assessment of GLC operation capability for pesticide work: ____________________
____
____

6. Is any check made in the early A.M. with a working standard solution to relate response characteristics to those of the pervious day's operation? Yes ☐ No ☐ Comment ____________________
____

PART F. RADIATION

Counting Room Facilities and Equipment

A. Counting Room Facilities

1. Are counting instruments located and operated in a separate counting room facility?

   Yes ☐ No ☐

2. Number and size of counting rooms : **Number** **Size**

3. Are instruments operated from regulated power?

   Yes ☐ No ☐

4. Is there an adequate ground available to all counting instruments?

   Yes ☐ No ☐

5. Can the light in the counting room that houses the liquid scintillation systems be readily controlled (for sample loading, etc.)?

   Yes ☐ No ☐

6. Are counting room facilities adequately protected (by location or shielding) from higher radiation areas and sources?

   Yes ☐ No ☐

7. Is there adequate temperature control in the counting room(s)?

   Yes ☐ No ☐

B. Special Questions

1. What beta emitter is used for gross beta calibration?

____

2. What alpha emitter is used for gross alpha calibration?

____

3. Are individual analyses logged in permanent type laboratory notebooks and initialed and dated by the analyst?

Yes ☐ No ☐

Comments :

4. Are working copies of all methods used readily available to the laboratory analyst?

Yes ☐ No ☐

Comments :

5. Are standard solutions prepared and stored in an area separate from areas where analysis of samples and blanks is being performed?

Yes ☐ No ☐

Comments:

6. How often are standards preparation areas and sample working areas being swiped and checked for radioactivity contamination?

____

Comments:

Equipment

Refer to Chart D, Section on Special Radiological Equipment, in the Preliminary Questionnaire.

For Alpha and Beta-particle Counters

Sample Changing
Manual ______
Automatic ______
Capacity ______

Instrument Background	Alpha	Beta
Operating voltage	______	______
cpm	______	______

Background Counts
Frequency ______
Log kept ______

For all Instruments

Frequency of calibration ______

Frequency of service maintenance ______

Alpha and Beta Particle Counters

Windowless Gas-flow Proportional Counter

Counting gas ______

Sample dish diameter ______

Thin Window Gas-flow Proportional Counter

Counting gas ______

Window density (g/cm^2) ______

Alpha Scintillation Counter

Alpha Phosphor location
Photo tube ______
Samples ______

Beta Scintillation Counter

Beta Phosphor
Type ______

Thickness ______

Diameter ______

Liquid Scintillation Counter

Discrimination channels 1 ________
2 ________
3 ________

Data readout

Visual

Printout, Channel 1 ________
2 ________
3 ________

Spectrometer Systems

Alpha Spectrometer (Surface Barrier Type)

Detector

Active diameter ________

Detectors/chamber ________

Analyzer

Channels ________

Gamma Spectrometer

Detector- size ________

Analyzer-Channels ________

Radon Gas Counter

Gas counting cells/system ________

Manufacturer of gas counting cells ____________________

____

METHODS USED IN THE CALCULATION OF RADIATION DATA

Analysis	"Hand" or Computer	Matrix or Least Squares	"Spectrum Stripping"	"Compton Subtraction"	Precision/Accuracy Reported	Opportunity for Final Recheck

CALIBRATED RADIOACTIVE SOURCES

Radionuclide	Supplier	Where Stored	Comments

SAMPLING GUIDELINES

Radionuclide	Media	Site	Site Selection Criteria	Sampling Procedures			
				Grab	Continuous	Other	Custody

SECTION 6
INSTRUCTIONS AND RATING SYSTEM

GENERAL INSTRUCTIONS

This section of the procedure provides instructions for the evaluators who will conduct the onsite survey. The laboratory visit is the most important part of the evaluation procedure. Thorough preparation is the key to its success. Unless ample time is devoted to prior preparation, an accurate laboratory evaluation will be impossible. "Ample" cannot be rigidly defined, for the time involved will vary according to: the talents and experience of individual evaluators; the information provided in the preliminary questionnaire; the number and variety of analyses that a laboratory performs; and the number of inspectors performing the site evaluation. A minimum of several hours preparation should be allotted for even the most straightforward situation.

Initially, the evaluators must completely familiarize themselves with the format and questions of the onsite checklist. This familiarity will facilitate the flow of the interviews. It will help the evaluators to anticipate laboratory reactions and to know when further probing of a response is necessary. When an evaluator is required to exercise judgment in rating a laboratory, close adherence to the procedural guidelines will enhance the objectivity of the judgement.

Upon receipt of the preliminary questionnaire, the evaluator must carefully study all the information provided. Although responsibility for different aspects of the laboratory evaluation may be divided among several members of an evaluation team, each evaluator should be familiar with the information contained in the entire report. A broad understanding of the background information provides a valuable resource for the evaluator who must assess a particular function such as quality control or analytical procedures.

For convenience, the onsite survey has been divided into three areas: (1) Management and Organization, (2) Tecnnical Services, and (3) Internal/External Controls. Detailed instructions, suggested questions and scoring procedures are provided for each of these areas.

Prior to the onsite visit, some scores may be calculated from the data recorded in the answers to the preliminary questionnaire. Careful study of the detailed instructions will indicate those items which can be pre-graded. In addition to the preliminary assignment of scores much can be done in preparation for the visit. For example, in the technical services section, the apparatus list can be compared with the requirements for each analysis allegedly performed to determine that the necessary equipment is on hand. If a laboratory states that it performs atomic absorption to determine cadmium but lists no cadmium hollow cathode, the analysis could not be done. Awareness of such discrepancies before the visit can highlight areas in need of the evaluator's scrutiny.

All questions suggested in the Evaluator's Guide will not require numerical scores. Some demand only the evaluator's positive or negative judgement in support of the overall laboratory score. However, there are a sufficient number to be rated on the score sheets to allow an objective laboratory evaluation which can be used for comparative purposes.

Numerical scores should not be computed onsite. The evaluator should gather information and check appropriate entries for possible scoring levels. At the end of the laboratory visit, the data should be reviewed, all confusion dispelled, and discrepancies resolved. The score can then be tabulated and the laboratory informed in writing of the outcome of the evaluation process. Items which require correction or improvement prior to final scoring should also be highlighted to afford the laboratory the opportunity to make the adjustments necessary for subsequent acceptance.

Some items are more crucial to laboratory operation and security than others. The onsite check list specifies certain conditions which must be present and satisfactory for a laboratory to be deemed qualified. These items are marked with an asterisk. For example, regardless of the excellence of facilities and analytical competency of an establishment, if it lacks adequate sample custody and control, it cannot be found acceptable. If an item in any part of the check list is marked with an asterisk, the problem must be resolved before the final score is calculated.

Suggested Sequence of Onsite Interviews

Interview #1 - Lab Director and Supervisors, (perhaps continued with supervisors collectively or individually). Parts of Onsite Questionnaire to be covered:
  Part 1. General Information about the Laboratory
  Part 2. Personnel (in part)
  Part 3. Laboratory Space and Facilities (in part)
Interview #2 (or Series of Interviews) - Supervisors with their laboratory personnel in the laboratories. (If number of supervised personnel is large, subdivide the group for convenience.)

Part to be covered:
  Part 2. Personnel (in part)
  Part 3. Laboratory Space and Facilities (in part)
  Part 4. Technical Service
  Part 5. Equipment List
  Part 6. Quality Control (in part)

Interview #3 Internal and External Controls - This may involve a designated quality control officer, a section with responsibility for review of operations, or an individual or individuals with part-time responsibility for quality control in the lab.

SPECIFIC INSTRUCTIONS AND RATING SYSTEM

Management and Organization Area - Parts 1, 2 and 3

This area does not readily lend itself to an objective evaluation. The questions frequently cannot be designed to elicit a "yes" or "no" response. Therefore, the judgements made by the evaluator are of great importance.

Guides are provided to help standardize the scores of the individual evaluators. The scoring system is designed so that the values assigned to any individual characteristic of the lab will affect the total score by only a small increment. Thus, although many laboratories with many different evaluators may be involved, scores should be comparable.

The experience gleaned from the onsite visit, from witnessing the attitude and manner of responses by laboratory personnel to questions, from watching the interplay between individuals when more than one is present during the onsite evaluation is essential to the assignment of scores to answers. The evaluator is responsible for the integration of all these factors to arrive at the decision to score each question with 5, 3, or 1.

The rationale for particular questions and the approach to their formulation may not always be apparent. Therefore, a statement of intent for each series of questions is provided in the "Evaluator's Guide", Section 5. This will help the evaluator to ask suggested questions and to develop a personal line of questioning.

If the laboratory is privately owned some determination of its financial stability should be made. Some information can be gained from the annual operating budget, fees charged for services and the number of analyses performed per year. Also the age and condition of the real estate and laboratory apparatus could indicate, in general terms, the health of the organization. Laboratory apparatus is expensive and a large investment is required to start an analytical laboratory. Much can be learned without demanding an audit or inspection of the books. A study of the annual report requested in the preliminary questionnaire should provide a good deal of information about the financial condition of the organization. If no fiscal information is contained in the annual report, some inquiries concerning the financial condition of the laboratory should be made.

Name of Lab ____________________

PART 1. GENERAL INFORMATION ABOUT THE LABORATORY

(1) Appropriateness of Organization

	Best Description of Laboratory	Score
☐	Responses to questions indicate the organization is as reported, and that its functioning is not so rigid as to interfere with operational requirements.	5
☐	Some doubt that organization as described is really followed. Chain-of-command is followed without deviation to the detriment of good performance.	3
☐	Serious doubts concerning organization and control of people.	1*

(2) Impairment of Functions

	Best Description of Laboratory	Score
☐	Responses generally satisfactory, no real problems in any of these areas. Certainly nothing said that would indicate impairment of laboratory functions.	5
☐	Some problems evident in one or two places. These may make it difficult to operate effectively.	3
☐	Management problems are obvious in several areas, hard to get help, customers complain, etc., and performance is likely to suffer.	1*

(3) Strength of Management

	Best Description of Laboratory	Score
☐	Firm stand taken concerning internal communications and cooperation between groups. Both annual and long-range plans are made and followed. Firm authority demonstrated without the feeling of an "absolute monarch." Impression given of "wide awake" management.	5
☐	Some weaknesses indicated in a few of the items.	3
☐	It appears that management is weak - no plans made for future - little cooperation or internal communications.	1*

(4) Objectivity of the Laboratory

	Best Description of Laboratory	Score
☐	Responses open and direct - no reason to doubt objectivity.	5
☐	Some aspects of relationships unclear. Objectivity not seriously questioned but some doubts.	3
☐	A conflict of interest exists, is clearly apparent in any part of the organization.	1*

(5) Cooperation Obtained

	Best Description of Laboratory	Score
☐	All information provided promptly. Cooperative attitude displayed by all personnel. Preliminary questionnaire distributed to proper persons for completion.	5
☐	Most information supplied readily. Satisfactory candid responses.	3
☐	Important information not provided and difficult to draw out answers. Cooperation of all not evident. Evaluation presented and no plans to make constructive use of the results.	1*

Note: A score of 1, when marked with an asterisk (1*) in any part of the check list must be resolved to the satisfaction of the evaluator before a final score is calculated.

Evaluator's Notes

PART 2. PERSONNEL

(1) Supervisor Training

	Best Description of Laboratory	Score
☐	Supervisors have degrees. Sufficient experience in place of degree.	5
☐	No degree and less than 5 years experience.	3
☐	No degree and insufficient experience.	1

(2) Supervisor Experience

	Best Description of Laboratory	Score
☐	The supervisors as individuals and as a group are highly trained and experienced.	5
☐	The supervisors meet general requirements but are weak in environmental monitoring work.	3
☐	Some of the group appear deficient in training and experience.	1*

(3) Job Descriptions

	Best Description of Laboratory	Score
☐	There is good agreement between description and what is done.	5
☐	There is some agreement between description and what is done but considerable deviation.	3
☐	General agreement only.	1

(4) Training Program

	Best Description of Laboratory	Score
☐	Formal training program exists and is followed.	5
☐	No formal training program but obviously some training is continued.	3
☐	Little evidence that training is done.	1

(5) Turnover Rate

	Best Description of Laboratory	Score
☐	Rate is less than 25%.	5
☐	Rate is 25-50%.	3
☐	Rate is greater than 50%.	1*

(6) General Morale

	Best Description of Laboratory	Score
☐	Management exhibits real concern for individuals, evidenced by central records kept for each individual showing advancement dates, promotions, training programs taken, participation in health programs. General morale of personnel is high.	5
☐	No formal central records are maintained but some effort made to encourage people. No evidence of serious morale problems.	3
☐	Little concern demonstrated for individuals. Morale problems are evident.	1

Evaluator's Notes

PART 3. LABORATORY SPACE AND FACILITIES

(1) General Characteristics

	Best Description of Laboratory	Score
☐	General characteristics of laboratory satisfactory.	5
☐	Impression of laboratory is only average.	3
☐	General features of the laboratory are poor.	1

(2) Office Space

	Best Description of Laboratory	Score
☐	16.7m^2 (180 sq. ft.) or greater/person.	5
☐	12.5-16.7m^2 (135-180 sq. ft.)/person.	3
☐	Less than 12.5m^2 (135 sq. ft.)/person.	1

(3) Laboratory Space

	Best Description of Laboratory	Score
☐	18.6m^2 (200 sq. ft.) or greater/person.	5
☐	13.9-18.6m^2 (150-200 sq. ft.)/person.	3
☐	Less than 13.9m^2(150 sq. ft.)/person.	1*

(4) Bench-top Space

	Best Description of Laboratory	Score
☐	1.2m (4 lin. ft.) or greater/person.	5
☐	0.9-1.2m (3-4 lin. ft.)/person.	3
☐	Less than 0.9m (3 lin. ft.)/person.	1

(5) Hood Space and Operation

	Best Description of Laboratory	Score
☐	Hoods sufficient in number and capability.	5
☐	Some additional hoods and/or capacity needed.	3
☐	Hoods inadequate for purpose intended.	1

(6) Storage Space Chemicals, Reagents, Glassware, Supplies †

	Best Description of Laboratory	Score
☐	Storage space adequate, accessible, and kept orderly.	5
☐	Storage space available but overtaxed.	3
☐	Storage space insufficient.	1

† NOTE

Further questions about inventory policy and materials identification are asked in Part 6.

(7) Sample Storage †

	Best Description of Laboratory	Score
☐	Sample storage space is adequate and necessary provisions are made for samples requiring special attention.	5
☐	Sample storage satisfactory in general but some special requirements are not fully met.	3
☐	Sample storage space is inadequate and inefficiently arranged.	1*

† NOTE

Further questions about control of samples appear in Part 6.

(8) Controlled Space

	Best Description of Laboratory	Score
☐	Controlled space necessary for performance of services offered by the laboratory is available. Responsibility for operation of these rooms is assigned and continuous check of conditions is maintained.	5
☐	Necessary rooms are available but control is slack and checks are made only daily.	3
☐	There are unsatisfied needs for controlled space and/or responsibility is not well defined and checking is less frequent than daily.	1*

(9) Library

	Best Description of Library	Score
☐	A library is available; it is easily accessible, orderly, and well looked after.	5
☐	There is a library but it is disorganized and difficult to use.	3
☐	No organized library exists and each section or staff member keeps own references, periodicals, etc.	1

(10) Safety Equipment and Procedures

	Best Description of Laboratory	Score
☐	Safety equipment is available, regulations are posted, and regular drills are held.	5
☐	Safety equipment is good but improvements in the lab safety program are needed.	3
☐	Safety equipment is not complete and an effective program does not exist.	1*

(11) Distilled Water/Deionized Water

	Best Description of Laboratory	Score
☐	Apparatus and water checked every day and kept in proper condition by one designated individual who keeps a record.	5
☐	Greater interval than one day between checks by designated individual.	3
☐	No one person responsible and no written procedure or records maintained.	1*

(12) Glassware Supply and Washing

	Best Description of Laboratory	Score
☐	Glassware supply and washing are satisfactory in all respects.	5
☐	More attention needs to be given to washing equipment or procedures.	3
☐	Careless job done of glassware washing.	1*

(13) Housekeeping

	Best Description of Laboratory	Score
☐	Laboratory has clean, neat appearance; movement and work are not impeded by clutter.	5
☐	Laboratory is clean but not as neat as should be expected.	3
☐	Poor housekeeping evident by dirt or clutter.	1

(14) Data Processing Equipment and Logistic Services

	Best Description of Laboratory	Score
☐	Communication facilities within and outside the laboratory good. Computing capability present.	5
☐	Communications within and outside laboratory are limited. Data processing facilities inconvenient to use.	3
☐	Laboratory and sections thereof are isolated and computing capability sufficient for timely results not available.	1

Evaluator's Notes

Technical Service Area - Parts 4 and 5

The technical services area encompasses analytical methods and instrumentation. The questions are straight-forward. They seek to determine the nature of analytical methods employed in the laboratory and the adequacy of the instruments used in these procedures.

All analytical methods must be Federal Register referenced or alternates which have been specifically approved by the Environmental Protection Agency. EPA approved water and radiation test methods are referenced in the Federal Register, Vol. 35, No. 199, October 16, 1973. Air test methods with EOA approval are referenced in the Federal Register Vol. 36, No. 228, November 25, 1971 and Vol. 38, No. 110, June 8, 1973. Air methods for stationary sources are referenced in Federal Register, Vol. 36, No. 247, Part II, December 23, 1971; Vol. 38, No. III, June 11, 1973; Vol. 39, No. 47, March 8, 1974; Vol. 40, No. 152, August 6, 1975; and Vol. 40, No. 194, October 6, 1975. The interim methods for algicides, chlorinated organic compounds and pesticides were issued by EPA's Environmental Monitoring and Support Laboratory. For non-referenced Biological Tests see Bibliography entries No. 6, 7, 8, and 9. See Ref. 4, Standard Methods, for Test No. 406, Standard Plate Count.

Prior to the onsite visit, the evaluator should compare the apparatus list in the preliminary questionnaire with the requirements for each analysis that the laboratory performs. The absence of essential equipment should be thoroughly investigated. If all necessary apparatus is available, the evaluator should carefully assess the condition of the instruments. To function properly, the analytical equipment should be inspected and serviced regularly.

In laboratories concerned with more than one medium, it may be desirable to score the different sections of the laboratory individually for Part 4 Analytical Methods and Part 5 Instruments. The separation of Charts C and D in the Preliminary Questionnaire, Section 4, by media will facilitate this.

The evaluator must complete a set of score sheets for Parts 4 and 5 for each section of the laboratory, if separate scores are desired.

Depending on the circumstance, the evaluators report might contain one over-all score for the laboratory or two or more scores, one for each media with which the laboratory is concerned.

A list of major equipment requirements for each analytical method is given in the Appendix. Prior to the onsite visit this list should be checked against the Analytical Methods circled in Chart C and the Instruments checked in Chart D of the Preliminary Questionnaire, Section 4, to verify that equipment is on hand to perform all the tests for which evaluation is being made. Ask questions about any observed discrepancies. Check the condition of the equipment and ascertain its capabilities in every instance for:

- Required Instruments

- Function Tests and Standardization of Instruments - It is important that calibration curves be available for all major instruments and that they have been checked recently and updated if necessary.

- Calibration Equipment - The availability of suitable calibration equipment is important. Standard weights and special thermometers should be traceable back to a standardizing agency such as the National Bureau of Standards. In air monitoring, especially, the calibration equipment available should be checked carefully. Is equipment available for basic calibration of flow measurement devices? Is the laboratory able to produce satisfactory standard atmospheres? Note mention of required calibration equipment in the Appendix, Major Equipment Requirements for Each Analytical Method.

PART 4. ANALYTICAL METHODS

(1) Reference Methods or Approved Alternates

	Best Description of Laboratory	Score
☐	All methods used are Federal Register referenced methods or specific EPA approval has been obtained.	5
☐	Some easily correctable minor deviations from referenced methods exist and steps are being taken to conform to standards.	3
☐	Some nonstandard methods which do not have specific EPA approval are in use.	1*

(2) Reagent and Media Preparation

	Best Description of Laboratory	Score
☐	Laboratory personnel are clearly aware of the importance of proper preparation, use, and storage of reagents and media, and laboratory procedures and practices are adequate to ensure same.	5
☐	Although personnel awareness and laboratory procedures regarding preparation, use, and storage of reagents and media are generally satisfactory, one or two examples of improper preparation, careless use, improper storage (time, temperature, container, etc.), inadequate records, or other unacceptable procedures or attitudes were noted.	3
☐	Personnel attitudes and/or laboratory procedures for ensuring proper preparation, use, and storage of reagents and media are not adequate.	1

(3) Performance According to Standard

	Best Description of Laboratory	Score
☐	Performance of analysts is closely supervised and all testing conforms to standards.	5
☐	The laboratory does not have a specific control program for each sampling procedure and analytical test and performance is uneven.	3
☐	Supervision of the analysts is lax and confusion exists about specific details of some control procedures.	1

Evaluator's Notes

PART 5. ANALYTICAL INSTRUMENTS

(1) Required Instrumentation

	Best Description of Laboratory	Score
☐	All required instrumentation is in good working condition.	5
☐	Some instrumentation is of doubtful quality or is in some degree of disrepair.	3
☐	Needed items of equipment are missing, are not adequate for satisfactory work, or are improperly maintained.	1*

(2) Function Tests and Standardization of Instruments

	Best Description of Laboratory	Score
☐	Instruments are maintained operative, accurate, and precise by regular functioning checks and by use of standard before unknown samples. Standard curves are available where-ever indicated.	5
☐	Instruments are periodically checked against zero point or other reference and examined for evidence of physical wear or inadequate maintenance.	3
☐	Instruments are checked only when they stop working or when excessive difficulties are experienced.	1

(3) Calibration Equipment

	Best Description of Laboratory	Score
☐	Necessary calibration equipment is available and in good working condition.	5
☐	Calibration equipment is of doubtful quality or is in some degree of disrepair.	3
☐	Needed items for calibration are missing, are not adequate for precise work, or are improperly maintained.	1

Evaluator's Notes

Internal and External Controls - Part 6

Quality control is an indispensable aspect of laboratory performance. Initiated by management's interest and concern and embodied in distinct operating procedures, commitment to quality performance should pervade all levels of the laboratory.

Concern for quality has many manifestations:

- Responsibility for quality control is clearly assigned.
- Analytical apparatus is adequately maintained and calibrations are performed frequently.
- Samples are carefully collected and identified, and promptly processed.
- Tests for precision and accuracy are employed to ascertain the validity of data.
- Laboratory uses quality control check (reference) samples on a scheduled basis.
- Laboratory records are assiduously kept and reports are completed regularly.
- The laboratory participates periodically in inter-laboratory proficiency tests.
- A training program exists for new employees; trainees' performance is monitored and evaluated.
- Corrective action procedures are available and can be quickly implemented when necessary

With the guidance of Internal and External Controls Part 6, the evaluator should explore the laboratory's provisions for quality control.

In addition to the operational components of a quality control plan, the evaluator must assess a number of intangibles. An atmosphere conducive to quality performance requires interest and enthusiasm, a cooperative working relationship between supervisor, analyst and technician, dedication, and a free flow of communication. Through insight and discussion, the evaluator must determine whether or not a sincere concern for quality control exists. The following guidance should assist the evaluator to make this judgment.

Control of Analytical Methods and Instruments

An effective environmental monitoring program must include a quality assurance plan to protect the validity of its data. Quality assurance has many components: calibration standards, standard reference material, careful maintenance of records, sample taking, sample processing and control, interlaboratory comparison studies and data validation. Maintenance and calibration of analytical apparatus are critical to the generation of good data. The evaluator must determine whether instruments and apparatus are maintained and how well, whether calibrations are performed in an appropriate manner and with sufficient frequency, and whether records and documentation of maintenance and calibration are adequate. If maintenance is done on an outside contract, determine for what instruments such contracts exist. The following items should be considered to assess the laboratory's quality assurance measurements.

- Assignment of Responsibility - The evaluator's first task will be to determine who has the responsibility to see that each of the instruments in Chart D in the preliminary forms is properly maintained and calibrated on schedule. This may or may not be the same person who actually does the maintenance and calibration. Here the intent is to evaluate whether the responsibility is clearly assigned or not. It may be useful to question several people, bench analysts and supervisors alike, on this point to see if the assignment of responsibilities is clearly and uniformly understood by all.

- Maintenance and Calibration Logs - For legal and scientific reasons, it is important to keep careful records of maintenance and calibration of instruments and apparatus. Generally, these records should be kept in permanent (bound) notebooks in ink with each entry signed and dated. A separate log (or a separate section of a log) should be assigned to each instrument or piece of apparatus that requires any sort of periodic calibration or maintenance, whether that activity is performed by laboratory personnel or by an outside agency under contract. It is convenient to include all calibration, maintenance, and repair actions on an instrument in the log, as a complete and accessible record of the conditions of that instrument. This includes evidence of traceability of standards to the National Bureau of Standards or other recognized source.

  Each entry must specify clearly what action was taken when and by whom. For example, if a new calibration curve was established which will be the basis for future analyses, either the curve or a reference to a notebook containing the curve should be included, along with an explanation of how the curve was established (identification of reference standards, methodology) and when the analyst began using the curve in "real sample" analysis.

- Adequacy of Calibration and Maintenance Practices - The evaluator now must assess the laboratory's actual procedures and practices for calibrating and maintaining its instruments and apparatus. The critical factors for purposes of this evaluation are the procedure itself. What maintenance checks are routinely performed? How is calibration done and the frequency and regularity with which it is carried out? This information should appear in the instrument calibration and maintenance logs and the laboratory quality control manual. If not, it will have to be obtained directly in conversations with the analysts and their supervisors. In either case, it will be important to discuss laboratory calibration and maintenance practices in the onsite visit and how to ascertain insofar as possible what is actually done and how frequently for each instrument. The evaluator should look for calibration tags on major pieces of instrumentation.

  Ideally, the evaluation would involve simply comparing this laboratory's practices to generally accepted standards, summarized in some Table or reference test. Unfortunately, there is no such Table or text that covers all instruments and apparatus employed in environmental monitoring.

  However, calibration recommendations for some of the major instruments are included in Table I. These "recommendations" are not to be considered rigid rules but rather guidelines for the evaluator in estimating laboratory performance. It is recognized that optimum procedures may vary somewhat as a function of instrument manufacturer and model. Additional materials that could be useful to the evaluator are operation and maintenance manuals for the various instruments and references in the Bibliography.

TABLE 1. INSTRUMENT CALIBRATIONS*

Instrument	Procedure	Frequency
1) Analytical Balances	(a) Zero	Before each use
	(b) Standard weights	Monthly
	(c) Full calibration and adjustment	Annually
2) pH Meters	At pH 4,7, and 10	Daily
3) Conductivity Meters	(a) Obtain cell constant with potassium chloride reference solutions	Daily
	(b) Construct temperature curve if measurements are to be made other than at 25 ± 0.5°C	Monthly
4) Nephelometer/ Turbidimeters	(a) Check instrument scales or develop calibration curve with formazin stds. (≤40NTU)	Monthly
	(b) If manufacturer's stds. are not formazine, check against formazine stds. (≤ 40NTU)	Annually
5) Colorimeters/Filter Photometers	Curves determined with 5-6 laboratory-prepared std. solutions for each parameter in conc. range of samples	Daily
6) UV/Visible Spectrophotometers	(a) Wavelength calibration with holimum oxide glass or solution, low-pressure mercury arc, benzene vapor (UV), or hydrogen arc (visible)	Quarterly
	(b) Absorbance vs. concentration curves with 5-6 std. Solutions for each parameter at analytical wavelength in conc. range of samples	Daily
	(c) Full servicing and adjustment	Annually

*Continued

TABLE 1. (Continued)*

Instrument	Procedure	Frequency
7) Infrared Spectrophotometers	(a) Wavelength calibration with polystyrene or indene	Daily
	(b) Absorbance vs. concentration curves with 5-6 std. solutions for each parameter at analytical wavelength in conc. range of samples	Daily
	(c) Full servicing and adjustment	Semi-annually
8) Atomic Absorption Spectrophotometers	(a) Response vs. concentration curves with 6-8 std. solutions for each metal (std. mixtures are acceptable, but with same acid as samples to be run) in conc. range of samples	Daily
	(b) Full servicing and adjustment	Annually
9) Carbon Analyzers	Curves determined with 5-6 std. solutions in conc. range of samples	Daily
10) DO Meters	Calibrated against modified Winkler method on aerated distilled or tap water	Daily
11) Other Selective Ion Electrodes and Electrometers	Curves determined with 5-6 std. solutions in conc. range of samples	Daily
12) Thermometers	Calibrate in constant temperature baths at two temperatures against precision thermometers certified by NBS.	Quarterly
13) Technicon Auto Analyzers	(a) Curves determined with std. solutions for each parameter.	Each set of samples
	(b) Full service and adjustment (esp. colorimeter)	Annually

*Continued

TABLE 1. (Continued)*

Instrument	Procedure	Frequency
14) Gas Chromatographs	(a) Retention times and detector response checked with std. solutions	Daily
	(b) Response curves for each parameter determined with std. solutions	Monthly
15) Radiological Equipment	(See Standard Methods, Sect. 300)	
16) Sulfur Dioxide in Air Sampler/Analyzers (Pararosaniline Method)	(a) Calibrate flowmeters and hypodermic needle against a wet test meter	Quarterly (Needles before and after each run)
	(b) Spectrophotometric calibration curve with 5-6 std. sulfite-TCM solutions at controlled temperature (± 1°C)	Monthly
	(c) Sampling calibration curve with 5-6 std. atomospheres from permeation tubes or cylinders	Monthly
	(d) Calibrate associated thermometers, barometers, and spectrophotometer (wavelength)	Quarterly
17) Suspended Particulates (High-volume Sampler Method)	(a) Calibrate sampler (curve of true airflow rate vs. rotameter or recorder reading) with orifice calibration unit and differential manometer at 6 air flow rates.	Monthly
	(b) Calibrate orifice calibration unit with positive displacement primary standard and differential manometers	Annually
	(c) Calibrate relative humidity indicator in the conditioning environment against wet-bulb/dry-bulb psychrometer	Semi-annually
	(d) Check elapsed time indicator	Semi-annually
	(e) Calibrate associated analytical balances, thermometers, barometers	As needed

*Continued

TABLE 1. (Continued)*

Instrument	Procedure	Frequency
18) Carbon monoxide (Non-dispersive IR)	(a) Determine linearity of detector response (calibration curve) with calibration gases (0, 10, 20, 40, and 80% of full scale, certified to ±2% and checked against auditing gases certified to ±1%)	Monthly
	(b) Perform zero and span calibrations	Daily or every three days
	(c) Calibrate rotameter and sample cell pressure gauge	Semi-annually
19) Photochemical Oxidants (Ozone)	(a) Calibrate standard KI/I_2 solutions in terms of calculated O_3 equivalents at 352 nm	At same time as ozone generator
	(b) Calibrate instrument response with 6-8 test atmospheres from ozone generator, spanning expected ranges of sample concentrations (usually 0.05-0.5 ppm O_3)	Monthly
	(c) Calibrate flowmeters, barometer, thermometer	Semi-annually
	(d) Calibrate and service spectrophotometer	As specified
	(e) Calibrate ozone generator	Monthly
20) Hydrocarbons (corrected for Methane)	(a) Determine linearity of detector response (calibration curve) with calibration gases (0, 10, 20, 40, and 80% of full scale, certified to ±2% and checked against auditing gages certified to ±1%)	Monthly
	(b) Perform zero and span calibrations	Before and after each sampling period
	(c) Calibrate flowmeters and other associated apparatus	Semi-annually

*Continued

TABLE 1. (Continued)

Instrument	Procedure	Frequency
21) Nitrogen Dioxide (Arsenite 24 hr. Sampling Method)	(a) Calibrate flowmeter with wet test meter	Monthly
	(b) Calibrate Hypodermic needle (flow restrictor) with flowmeter	Each new needle and before and after each run
	(c) Obtain colorimetric calibration curves with 5-6 std. nitrite solutions	Weekly
22) Nitrogen Dioxide (Chemiluminescence, Continuous)	(a) Determine linearity of detector response (calibration curve) with calibration gases (0, 10, 20, 40, and 80% of full scale, certified to ±2% and checked against auditing gases certified to ±1%)	Monthly
	(b) Perform zero and span calibrations	Daily or every three days
	(c) Calibrate rotameter and sample cell pressure gauge	Semi-annually
23) Autoclaves and Sterilizers	(a) Sterilization effectiveness checked (e.g., B. stearothermophilus, color-indicator tape for ethylene oxide)	Daily
	(b) Temperature-recording device calibrated	Semi-annually

Control of Sampling

- Sampling Plans and Sampling Equipment - The intent of this item is to determine whether adequate attention has been given to planning for sampling, whether appropriate sampling instruments are available, and whether they are used properly.

  Sampling is the operation of removing a part which is of convenient size for testing from a much larger whole substance in such a way that the measure of the characteristic of interest (such as pH or chemical analysis) in the sample is identical, within measureable limits of error, to that characteristic's presence in the whole substance. It is necessary that sampling be planned carefully in order to measure and control sampling errors and minimize the cost of sampling and testing.

  If the substance to be sampled consists of discrete, constant, identifiable units (as do agricultural commodities tested for pesticide residues) standard sampling tables may be used to determine sample size. However, in environmental sampling the media are of a bulk nature (air, water, etc.) and the sampling units must be created by means of a sampling device, such as a bottle or sampling tube. The quantity and often the form of the sample units depends on the particular device, how it was used, and on the location and condition of the substance being sampled.

  Sampling may be instantaneous at a given station (grab sampling) or continuous and automatic. Validity of sampling depends on randomness of selection of the samples. Where stratification exists, random samples must be taken from each stratum in proportion to its size. When the statistical criteria have been met, the required sample size may be calculated.

  The design of sampling is seen to require some special skills and the person responsible for it must have considerable sophistication in handling the statistical aspects.

  Generally, sampling instruments and their use are described in the analytical methods and questions related to sampling should be asked for each test or group of test methods.

- Sample Collection and Preservation - The evaluator will want to determine sample taking and preservation practices for at least some of the tests performed by the laboratory. For evaluation purposes, these practices can be compared with the recommendations incorporated in Table 2 of the EPA Manual - *Methods for the Chemical Analysis of Water and Wastes,* for most water parameters; the Federal Register for air parameters (Sect. 4, Precision, Accuracy and Stability, for each method); Standard Methods: Sections 405 (microbiological), 200 and 300A (radiological); and the specified references in the Analytical Methods Table C, Section 4, for the remaining parameters (57-60).

The holding time given in Table 2 of the EPA Manual is interpreted as the recommended maximum period between sampling and analysis. Preservatives, where specified, are required to ensure stability for the holding time. Look at records, at sample bottles, etc., to assure yourself that good procedures are actually followed. If holding times are exceeded, a notation of that fact should be made on data sheets before they are transmitted.

For some tests, to exceed the maximum holding time would very seriously compromise the accuracy of the measurement. If the laboratory is exceeding the maximum holding time for these tests, the laboratory must be given a score of 1* and the problem must be resolved before a final score is calculated. The parameters to which this applies include the following:

Biochemical Oxygen Demand (Dissolved Oxygen)

Cyanide, Total

Chlorine, Total Residual

Phenols

Turbidity

Streptococci

Coliform Bacteria

Temperature

pH

- Identification and Storage of Samples - All samples should be clearly marked with a code number at the time of sampling. Labels should be securely attached to the sample container. In the field, information about the sample should be entered immediately in a field notebook. In handling and storing the samples precautions should be taken against mix-up in identification.

Storage space should permit storage of samples in a separate area, refrigerated if necessary for preservation, and secured against tampering.

- Laboratory Handling of Sampling - The flow of samples through the laboratory should be organized. Forms should be available for requests for analysis and for reporting of results. Sample handling procedures should be formalized so that samples arriving at the lab are accepted, prepared and analyzed promptly. Holding times given in Table 2 should be adhered to. For air, requirements given in the referenced methods should be followed.

- Chain of Custody - Assignment of responsibility for custody of samples should be clear and the importance of a tight system of control should be understood by all. The procedures to be followed should be written. Samples should be logged in and their progress through the labs should be recorded and the samples themselves should be in a secure location when not signed out to an analyst.

- Control of Field Sampling/Measurements - The requirements of sampling in the field are as demanding as those of sampling in the laboratory. Most sample taking is a field operation. Sometimes measurement also must be done in the field. Certain special analytical methods or modifications of standard methods apply. Also, other measurements, such as flow rates, not made in the laboratory must be done in the field.

  Questions should be directed toward an understanding of how well the field aspects of sampling and testing are attended to when done by laboratory personnel or when done by a service agency.

- Control of Monitoring - The important thing to be checked for in this item is whether written procedures cover all monitoring activities in which the laboratory is engaged and whether they are being followed exactly.

TABLE 2. RECOMMENDATION FOR SAMPLING AND PRESERVATION OF SAMPLES ACCORDING TO MEASUREMENT (1)*

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time(6)
Acidity	100	P, G(2)	Cool, 4°C	24 Hrs.
Alkalinity	100	P, G	Cool, 4°C	24 Hrs.
Arsenic	100	P, G	HNO_3 to pH < 2	6 Mos.
BOD	1000	P, G	Cool, 4°C	6 Hrs.(3)
Bromide	100	P, G	Cool, 4°C	24 Hrs.
COD	50	P, G	H_2SO_4 to pH < 2	7 Days
Chloride	50	P, G	None Req.	7 Days
Chlorine Req.	50	P, G	Cool, 4°C	24 Hrs.
Color	50	P, G	Cool, 4°C	24 Hrs.
Cyanides	500	P, G	Cool, 4°C NaOH to pH 12	24 Hrs.
Dissolved Oxygen Probe	300	G only	Det. on site	No Holding
Winkler	300	G only	Fix on site	No Holding
Fluoride	300	P, G	Cool, 4°C	7 Days
Hardness	100	P, G	Cool, 4°C	7 Days
Iodide	100	P, G	Cool, 4°C	24 Hrs.
MBAS	250	P, G	Cool, 4°C	24 Hrs.
Metals Dissolved	200	P, G	Filter on site HNO_3 to pH < 2	6 Mos.
Suspended			Filter on site	6 Mos.
Total	100		HNO_3 to pH < 2	6 Mos.

*Continued

TABLE 2. (Continued)*

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time(6)
Mercury				
Dissolved	100	P, G	Filter HNO_3 to pH < 2	38 Days (Glass) 13 Days (Hard Plastic)
Total	100	P, G	HNO_3 to pH < 2	38 Days (Glass) 13 Days (Hard Plastic)
Nitrogen				
Ammonia	400	P, G	Cool, 4°C H_2SO_4 to pH < 2	24 Hrs.(4)
Kjeldahl	500	P, G	Cool, 4°C H_2SO_4 to pH < 2	24 Hrs.(4)
Nitrate	100	P, G	Cool, 4°C H_2SO_4 to pH < 2	24 Hrs.(4)
Nitrite	50	P, G	Cool, 4°C	24 Hrs.(4)
NTA	50	P, G	Cool, 4°C	24 Hrs.
Oil & Grease	1000	G only	Cool, 4°C H_2SO_4 to pH < 2	24 Hrs.
Organic Carbon	25	P, G	Cool, 4°C H_2SO_4 to pH < 2	24 Hrs.

*Continued

TABLE 2. (Continued)*

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time(6)
pH	25	P, G	Cool, 4°C Det. on site	6 Hrs.(3)
Phenolics	500	G only	Cool, 4°C H_3Po_4 to pH < 4 1.0 g $CuSO_4/1$	24 Hrs.
Phosphorus				
Ortho-phosphate	50	P, G	Filter on site	24 Hrs.(4)
Dissolved			Cool, 4°C	
Hydrolyzable	50	P, G	Cool, 4°C H_2SO_4 to pH < 2	24 Hrs.(4)
Total	50	P, G	Cool, 4°C	24 Hrs.(4)
Total, Dissolved	50	P, G	Filter on site Cool, 4°C	24 Hrs.(4)
Residue				
Filterable	100	P, G	Cool, 4°C	7 Days
Non-Filterable	100	P, G	Cool, 4°C	7 Days
Total	100	P, G	Cool, 4°C	7 Days
Volatile	100	P, G	Cool, 4°C	7 Days
Settleable Matter	1000	P, G	None Req.	24 Hrs.
Selenium	50	P, G	HNO_3 to pH < 2	6 Mos.
Silica	50	P only	Cool, 4°C	7 Days
Specific Conductance	100	P, G	Cool, 4°C	24 Hrs.(5)

*Continued

TABLE 2. (Continued)

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time(6)
Sulfate	50	P, G	Cool, 4°C	7 Days
Sulfide	50	P, G	2 ml zinc acetate	24 Hrs.
Sulfite	50	P, G	Cool, 4°C	24 Hrs.
Temperature	1000	P, G	Det. on site	No Holding
Threshold Odor	200	G only	Cool, 4°C	24 Hrs.
Turbidity	100	P, G	Cool, 4°C	7 Days

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1. More specific instructions for preservation and sampling are found with each procedure as detailed in this manual. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 23, p. 72-91 (1973).

2. Plastic or Glass

3. If samples cannot be returned to the laboratory in less than 6 hours and holding time exceeds this limit, the final reported data should indicate the actual holding time.

4. Mercuric chloride may be used as an alternate preservative at a concentration of 40 mg/l, especially if a longer holding time is required. However, the use of mercuric chloride is discouraged whenever possible.

5. If the sample is stabilized by cooling, it should be warmed to 25°C for reading, or temperature correction made and results reported at 25°C.

6. It has been shown that samples properly preserved may be held for extended periods beyond the recommended holding time.

Quality Control

- Quality Policy - To ascertain that quality control is a pervasive concern; one that merits attention not only at critical points, but daily in the routine performance of analyses. There should be a clear statement of policy by management.

- Quality Program Manual - To identify the means by which quality control procedures are disseminated in the laboratory.

- Responsibility for Quality - To determine which person or group of people assumes responsibility for quality control.

- Training in Quality Control - To determine what measures are used to prepare employees to meet quality control standards.

- Control of Chemicals and Reagents - To assess the laboratory's methods for monitoring the flow of chemicals and reagents. Procurement control includes equipment and other materials as well as chemicals and reagents.

- Intra-Laboratory Checks; Precision and Accuracy - An analytical laboratory must have a well-organized and clearly defined program to check the validity of the data it produces. Validity is usually expressed in terms of precision and accuracy. According to the EPA *Handbook for Analytical Quality Control in Water and Wastewater Laboratories*, "precision refers to the reproducibility among replicate observations", and "accuracy refers to a degree of difference between observed and known, or actual values".

  An analyst initially may establish the precision of a particular method by 5-10 replicate determinations on a single "real sample". Generally, it will be necessary to repeat this procedure on each of the various types of samples that will be analyzed by this method (e.g., surface water, industrial effluent, sea water, etc) and preferably on several samples of each type from a variety of sources. Comparison of the precision obtained with reference standards and that obtained with actual samples will reveal any interferences from contaminants in the complex samples.

  The accuracy of a method may be determined initially by 5-10 replicate analyses of samples to which known amounts of reference standards have been added (spiked samples). The EPA AQC Handbook mentioned above suggests reporting the results as "percent recovery at the final concentration of the spiked sample". The spiking of actual samples for these determinations allows for a more realistic measurement of accuracy than the exclusive use of pure reference standards, although again comparison of the accuracy obtained with spiked samples and that obtained with reference standards may be of interest in identifying the source of errors. Analysis of blanks also will be important for many parameters where the apparent background level may be non-zero and where a blank correction may be necessary.

- Routine Checks of Testing Performance - After the precision and accuracy of the method are established, the analyst will need to incorporate replicates, spikes, standards, and blanks, as appropriate, into the sequence of routine analyses to ensure that valid data is being generated. The frequency and procedures required for adequate monitoring of the quality of the data will depend on the method itself. The evaluator will find some guidance as to what is adequate in the references in the Bibliography, particularly in the EPA AQC Handbook mentioned above, the *EPA Guidelines for the Development of a Quality Assurance Program* (for various air parameters), and the Methods Manuals (EPA, ASTM, Standard Methods). The experience of conscientious analysts and statisticians in the field of environmental monitoring is an invaluable source in this matter. For example, one group of water chemists experienced on the Technicon Auto Analyzer usually runs a duplicate, a spiked sample, and a reference standard every 8 samples in a large series of similar samples, or once in each set of samples, whichever is more frequent. A chemist experienced in the analysis of Phenols and Cyanide suggests verifying the standard curves each day that these parameters are analyzed with a low and a high reference standard and a blank and running a duplicate and a spike with each small set of samples. Gas chromatography often requires multiple injections of the sample with and without an internal standard, in addition to spiked samples and a blank, for each sample analyzed. These examples are given only to demonstrate how quality control protocols will vary considerably with the method and the experience of the analyst. The nature of the samples (simple or complex mixtures), the condition of the instrument, the importance of the sample (e.g., for enforcement action), the breadth of the precision and accuracy control limits, and many other factors may also affect the quality control requirements.

Because there are no universal guidelines for the frequency and procedures required in the use of quality control samples, it is very important that each laboratory develop its own internal guidelines based on sound statistical methods and experience. These should be in the form of written, explicit protocols for each test or group of tests. Statistical methods for the development of such protocols are discussed in the quality control references in the Bibliography and in standard quality control texts.

For purposes of this evaluation it will be of primary importance to determine if the analyst and the laboratory have a proper appreciation of the importance of replicates, spikes, standards, and blanks in assuring the validity of their analytical data. Since the evaluator is not expected to be an expert with long experience in the performance of every method, this evaluation does not place heavy emphasis on the content of the detailed protocols for replicates, spikes, standards, and blanks used by the laboratory. Rather, emphasis is laid on an assessment of the concern for and awareness of quality control evidenced and practiced by the analyst and the laboratory as a whole, as discussed below. The evaluator is asked to make a judgment as to whether quality control samples are run with sufficient frequency, but it is recognized that the evaluator may have little experience in many methods and may wish to place proportionately little weight on this judgment. The evaluator, nonetheless, should carefully record and document laboratory practices, so that patterns of quality control procedures can be developed.

The evaluator will want to discuss in the onsite visit the actual laboratory protocol for the use of replicates, spiked samples, reference standards, and blanks for each test. Some tests, of course, can be considered in groups with similar requirements (e.g., metals determined by atomic absorption or many of the tests determined on the Technicon Auto Analyzer). Questions to be asked by the evaluator for each parameter (method) include the following:

> Is there a formal protocol in this lab for the control of analytical performance of this method, including specifications of the frequency of and procedures for replicate sample, spiked sample, reference standard, and blank analyses, where applicable?
>
> Are the analysts familiar with the protocol? Does the protocol appear to vary from analyst to analyst?
>
> Have the precision and accuracy of the method been determined in this laboratory? By each analyst using the method? How frequently?
>
> Are replicates, spiked samples, reference standards, and blanks, if applicable, run with sufficient frequency to assure that precision and accuracy are remaining within the control limits?
>
> Is there a well-defined and clearly understood procedure for evaluating the data and for handling "out-of-control" data?

Have you developed acceptance criteria for data (could be three-sigma limits)? Is corrective action taken on lack of control? One of the basic procedures of statistical quality control is to associate troubles with specific causes. Does the laboratory try to do this?

The answers to these and other questions the evaluator may develop should offer a clear impression of the effort devoted by laboratory and analyst to assuring that valid data is produced for each parameter.

The score given is to be based on the laboratory's quality control procedures, particularly as they relate to replicates, spiked samples, reference standards, and blanks, if applicable, and the analyst's familiarity and understanding of the procedures.

- Statistical Methods - A popular method of monitoring daily performance is the use of Quality Control Charts. Basically, these charts, constructed separately for each test, display control limits for precision and accuracy. The precision and accuracy measured from day to day are plotted on these charts which provide a continuous visual picture of the control of data quality. Details will be found in textbooks on Quality Control and in the two EPA publications, *Handbook for Analytical Quality Control in Water and Wastewater Analysis* and *Quality Control Practices in Processing Air Pollution Samples*. The control chart method is particularly helpful is assisting in identifying causes of trouble in the measurement process: both special causes within the power of the analyst to correct and general causes, such as fluctuations in the laboratory environment, which are the duty of management to correct.

- Inter-Laboratory Proficiency Tests - Refer to Chart E of the Preliminary Questionnaire. Question the lab about results of participation in formal programs. Ask questions about cooperation with peer laboratories in the exchange of split samples, as another sort of inter-laboratory control.

- Laboratory Records - Accurate records provide a means for the laboratory to monitor its workload, locate errors, and evaluate its own progress. All three functions contribute to quality control and, therefore, should be assessed from this perspective. How does management decide whether data are satisfactory? Can data be rejected in this laboratory? (i.e., Are new samples collected and analyzed if results are suspect?) Are results recorded in an acceptable manner (in a notebook, on bench cards, or on NCR data forms)?

- Laboratory Reports - Regularly scheduled laboratory reports may function as a catalyst to continuous awareness of the importance of quality control. They are evidence both of managements' demand and analysts' effort to achieve excellence in quality control.

Evaluator's Notes

PART 6. INTERNAL AND EXTERNAL CONTROLS

1. Control of Analytical Methods and Instruments

(1) Assignment of Responsibility for Maintenance and Calibration

	Best Description of Laboratory	Score
☐	Responsibility is clearly assigned in this laboratory and understood by all personnel.	5
☐	Responsibility is assigned but not clearly recognized or understood by assignee(s) or other personnel.	3
☐	Responsibility is not clearly assigned or recognized in this laboratory.	1

(2) Maintenance and Calibration Logs

	Best Description of Laboratory	Score
☐	The instrument logs are properly executed, complete, and up-to-date.	5
☐	An instrument log exists but is faulty.	3
☐	An instrument log does not exist.	1

(3) Adequacy of Calibration and Maintenance Practices

	Best Description of Laboratory	Score
☐	Calibration and maintenance of instruments is adequate.	5
☐	Marginal.	3
☐	Inadequate.	1*

2. Control of Sampling

(4) Sampling Plans and Sampling Equipment

	Best Description of Laboratory	Score
☐	Samples are carefully designed, suitable sampling equipment is on hand and is used properly.	5
☐	Sampling is taken for granted and no particular efforts are made to assure validity of samples.	3
☐	Sampling is not organized, equipment is poor, or insufficient care is taken in obtaining the samples.	1

(5) Sample Collection and Preservation

	Best Description of Laboratory	Score
☐	Samples are kept in proper containers using the recommended preservative for no longer than the recommended maximum holding time.	5
☐	When possible, the recommended procedures for collection and preservation are followed, although circumstances (laboratory manpower, lack of control over sample taking, variability of workload, etc.) do not always allow strict adherence.	3
☐	The laboratory often does not follow EPA recommendations for maximum holding time, preservation technique, and/or container type.	1

(6) Identification and Storage of Samples

	Best Description of Laboratory	Score
☐	Samples are carefully and clearly identified by code number and stored so as to protect their identity and security.	5
☐	Sample identification system and storage of samples not well organized.	3
☐	There are serious defects in sample identification and storage practices that could lead to serious mix-ups.	1*

(7) Laboratory Handling of Samples

	Best Description of Laboratory	Score
☐	Activities of the laboratory are well organized so that samples are given the attention required and work proceeds smoothly from sample receipt to report of results.	5
☐	Procedures for assuring smooth flow of samples through the laboratory are not complete.	3
☐	The system and load are not well matched so that there is a backlog of work and time requirements are sometimes missed.	1

(8) Chain of Custody

	Best Description of Laboratory	Score
☐	A chain of custody procedure is followed precisely, with clearly assigned responsibility, complete recording of activities, and careful security of samples.	5
☐	A chain of custody procedure exists but it is lax and not strictly followed.	3
☐	Chain of custody is not formally organized.	1*

(9) Control of Field Sampling/Measurements †

	Best Description of Laboratory	**Score**
☐	Written procedures for field sampling/ measurements are complete and are followed meticulously under surveillance by the laboratory.	5
☐	Field sampling/measurement are subject to standard methods but surveillance by the laboratory is lax.	3
☐	Field sampling/measurement is not treated as a major concern of the laboratory.	1

† NOTE

If the laboratory does not participate in this activity, do not score it and subtract 5 from the denominator of the fraction in the formula for calculating its score for internal and external controls.

(10) Control of Monitoring †

	Best Description of Laboratory	**Score**
☐	Written procedures which are followed exactly are available for all monitoring activities in which this laboratory is engaged.	5
☐	Written procedures exist but they are incomplete and not followed exactly.	3
☐	No written procedures exist.	1

† NOTE

If the laboratory does not participate in this activity, do not score it and subtract 5 from the denominator of the fraction in the formula for calculating its score for internal and external controls.

3. Quality Control

(11) Quality Policy

	Best Description of Laboratory	Score
☐	A clear statement of quality objectives by the top executive exists with continuing visible evidence of its sincerity to all levels of the organization.	5
☐	Periodic meetings among the section heads of service, research and development, and quality assurance are held to discuss quality objectives and progress toward their achievement.	3
☐	There was a "one-shot" statement of the desire for product quality by the top executive after which the quality control staff is on its own.	1

(12) Quality Program Manual

	Best Description of Laboratory	Score
☐	Formalized and documented by a set of procedures which clearly describe the activities necessary and sufficient to achieve desired quality objectives. This may be in the form of a Quality Control Manual.	5
☐	The Quality Program is contained in methods procedures or is implicit in those procedures. Experience with the materials, product and equipment is needed for continuity of control.	3
☐	The Quality Program is undefined in any procedures and is left to the current managers or supervisors to determine as the situation dictates.	1*

(13) Responsibility for Quality

	Best Description of Laboratory	Score
☐	Responsibility for quality is a full-time assignment of a quality control department with well-defined authority or in smaller laboratories is clearly defined for all sections and section chiefs.	5
☐	Responsibility for quality is assigned to a part-time quality control coordinator who must use whatever means possible to achieve quality goals.	3
☐	Responsibility for quality is not defined.	1*

(14) Training for Quality Control

	Best Description of Laboratory	Score
☐	The people who have an impact on quality (bench chemists, supervisors, etc.) are trained in the reasons for and the benefits of standards of quality and the methods by which high quality can be achieved.	5
☐	Personnel are told about quality only when their work falls below acceptable levels.	3
☐	Personnel are reprimanded when quality deficiencies are directly traceable to the chemists' analytical work.	1

(15) Control of Chemicals and Reagents

	Best Description of Laboratory	Score
☐	Reagents and chemicals are inspected upon receipt and accepted only if they conform to all specifications. In inventory they are identified as to type and age and issued on a first in/first out plan.	5
☐	Reagents and chemicals are only spot checked for quantity and shipping damage; in storage they are identified as to material only and are issued randomly.	3
☐	Reagents and chemicals are not checked on receipt, are not clearly identified, and are issued on a last in/first out basis.	1

(16) Intralaboratory Checks - Precision and Accuracy

	Best Description of Laboratory	Score
☐	Laboratory has a well-organized program to check the validity of data it produces.	5
☐	Incomplete information is available on precision and accuracy of the tests in use.	3
☐	Laboratory has no plan to check on validity of its data.	1

(17) Routine Checks of Testing Performance

	Best Description of Laboratory	Score
☐	Procedures are excellent and should provide adequate assurance that the data is valid.	5
☐	Procedures are fair and should provide some indication of the validity of the data.	3
☐	Procedures are poor or poorly defined and do not provide adequate assurance that the data is valid.	1*

(18) Statistical Methods

	Best Description of Laboratory	Score
☐	Use is made of statistical methods, such as control charts to insure continuing validity of tests.	5
☐	Some statistical checks of measurements are made but level of assurance of quality is uncertain	3
☐	No efforts are made to use statistical methods of quality control.	1

(19) Interlaboratory Proficiency Tests

	Best Description of Laboratory	**Score**
☐	The laboratory has a good record of participation in formal proficiency tseting and has a good record of performance.	5
☐	Laboratory participates only sporadically and not recently. Performance in programs not outstanding.	3
☐	Laboratory does not participate in proficiency testing programs.	1*

(20) Laboratory Records

	Best Description of Laboratory	**Score**
☐	Analytical results are entered in a lab notebook or in a card system which is signed and witnessed. Results are summarized and entered in appropriate data system promptly.	5
☐	Analytical results are complete but they are not routinely signed and witnessed. Data processing is not always prompt.	3
☐	Data keeping is not organized, i.e., results kept on loose sheets of paper and incompletely reviewed and analyzed.	1

(21) Laboratory Reports

	Best Description of Laboratory	**Score**
☐	Lab activities are reported regularly and periodic quality reports are made to feed forward to management and to feed back to bench analysts quality of the work reported.	5
☐	Laboratory reports are sporadic and quality reports do not result in bringing necessary information for action on quality to all levels of the organization.	3
☐	Reports are very irregular and no system for quality reporting exists.	1

FOLLOW-UP ON DEFICIENCIES

The goal of laboratory evaluation is the improvement of laboratory performance. Identification of deficiencies is not intended to bar a laboratory from participation in environmental monitoring. Rather, it indicates that improvements are necessary to enable the laboratory to fulfill its role optimally.

Certain aspects of laboratory activity are more crucial to successful environmental monitoring than are others. It is the evaluator's responsibility to insist that rigid standards are met in these critical areas before the laboratory receives a final score. In the Onsite Check List, problems which must be resolved to the evaluator's satisfaction prior to approval are marked by an asterisk next to the lowest possible score (1*).

Unacceptable deficiencies may be indicated in each area of laboratory evaluation: Consistently high turnover rates, customer complaints, lack of cooperation among laboratory employees, and obstacles to internal communication are symptoms of poor organization and management which could seriously impair laboratory operation. Supervisors who have neither degrees nor sufficient experience may jeopardize the laboratory's analytical capabilities. Inadequate space, whether it be laboratory space, storage space or controlled space, impedes orderly laboratory functioning. Incomplete safety equipment may endanger both successful analyses and laboratory personnel. The use of nonstandard methods, the absence of essential instruments, or the malfunction of instruments as a result of improper maintenance, may compromise all analytical results. Failure to employ rigid quality control procedures may also raise serious doubts concerning the validity of laboratory data. If the quality assurance plan is not clearly defined, and responsibility for its execution is not assigned; if a chain of custody of samples is not established and followed; if sample storage exceeds the recommended maximum holding time; or if calibration is inadequate; the reliability of the laboratory's work may be impugned.

To protect the scientific and legal defensibility of the data, the evaluator must ensure that environmental monitoring laboratories are free of these deficiencies. Any inadequacies discovered by the evaluator should be brought to the attention of the laboratory management immediately, before completion of the onsite visit. The evaluator may offer recommendations for remedial action or stipulate essential adjustments which *must* be made before the laboratory may be scored.

After discussion with laboratory management, the evaluator should make note of the exchange and then compute a *tentative* score for the laboratory. The final score cannot be computed, nor approval given, until the laboratory has submitted evidence that all deficiencies have been corrected.

SECTION 7
CALCULATION OF SCORE

ACCEPTABILITY OF A LABORATORY

The Procedure for the Evaluation of Environmental Monitoring Laboratories strives to construct a standardized system for the objective appraisal of laboratory management, personnel, equipment, analytical capabilities and quality control procedures. The numerical scoring system plays an integral role in achieving this end. It provides a means to organize the multiplicity of data and to produce a manageable result. The values assigned to individual characteristics of the laboratory affect the total score by very small increments. This affords a measure of uniformity to laboratory assessment which is essential for the comparison of results compiled by a variety of evaluators in diverse situations.

The numberical scoring system is based upon 100 points. Each item may be rated with 5 points, 3 points, or 1 point. While onsite, the evaluator should check on the score sheets the scoring level for each item. If the level checked is scored one followed by an asterisk (1*) the laboratory fails to meet required specifications. The laboratory must resolve the deficiency before a final score can be computed.

After the onsite survey has been completed, the evaluator should use the summary sheets to calculate the numerical scores. On these forms, each item's score is weighted according to its importance for successful laboratory operation. After summing the weighted scores, performing the calculation at the bottom of the page produces the final score for each section.

Addition of the scores for each section provides the laboratory's final evaluation score. The highest possible score is 100 points. The minimum acceptable score is 60 points. Laboratories which score below this minimum require major improvements to be capable of participation in environmental monitoring programs.

If separate scores are desired for each section of a laboratory which deals with different media, the evaluator must have completed during the onsite visit a set of score sheets for Part 4 Analytical Methods and Part 5 Instruments for each section. In the event that this has been done, a total score is obtained for each section of the laboratory by adding to the separate scores on Parts 4 and 5, the general scores given the Laboratory on Management and Organization (Parts 1, 2, 3) plus Part 6, Internal and External Controls. Thus, a laboratory may obtain an overall score or two or more scores covering individual media with which it is concerned.

When the evaluator has computed the score for a laboratory, this score coupled with the evaluator's recommendations and comments should be sent to the participating lab. Laboratories which fail to meet required standards may later submit proof of adjustments made in compliance with the evaluator's recommendations to receive an upward revision.

In special circumstances, such as in evaluating very small laboratories, it may be desirable to drop one or more questions from the onsite score sheets. This should be done only after due deliberation by the evaluating agency. In no instance should the evaluation team arbitrarily eliminate or "forget" any question. If, for valid reasons, a question is dropped from a Part, the prorating of the score on the Scoring Forms may be accomplished as follows:

Multiply by five (5) the assigned weight in Column (2) of the question dropped and subtract the product from the denominator in the calculation of score for that part. Make such an adjustment for each question dropped. For example, if Question 4, Bench-Top Space, is dropped from Part 3, Laboratory Space and Facilities, the weight (Col. 2) is 1, the denominator 100 is reduced by 5x1 to 95 and calculation of score proceeds as indicated.

A report to the laboratory management might contain the following sections:

1. Recommendations to improve overall performance

2. Amplification of recommendations for any equipment or instrument purchases.

PART 1. SCORE FOR GENERAL INFORMATION ABOUT THE LABORATORY

Name of Laboratory ______________________________

		(1) Score	X	(2) Weight	=	(3) Extension
Question 1.	Appropriateness of Organization*			2		
Question 2.	Impairment of Functions*			2		
Question 3.	Strength of Management*			4		
Question 4.	Objectivity of Laboratory*			1		
Question 5.	Cooperation Obtained*			1		______
	TOTAL					

Calculation:

$$\frac{\text{Total Col (3)}}{50} \times 20 =$$

Enter this figure in box below and carry it forward to Summary Evaluation.

Score carried forward to Summary Evaluation. ☐☐

*Any score of 1 in positions in Col (1) marked with an asterisk must be resolved before the final score is calculated.

Date ______________________ Visit Conducted by ______________________

PART 2. SCORE FOR PERSONNEL

Name of Laboratory ______________________________

		(1) Score	X	(2) Weight	=	(3) Extension
Question 1.	Supervisor Training			1		
Question 2.	Supervisor Experience*			2		
Question 3.	Job Descriptions			1		
Question 4.	Training Program			2		
Question 5.	Turnover Rate*			2		
Question 6.	General Morale			2		______
	TOTAL					

Calculation:

$$\frac{\text{Total Col (3)}}{50} \times 20$$

Enter this figure in box below and carry it forward to Summary Evaluation.

Score carried forward to Summary Evaluation. ☐☐

---

*Any score of 1 in positions in Col (1) marked with an asterisk must be resolved before the final score is calculated.

Date ______________________________ Visit Conducted by ______________________

PART 3. SCORE FOR LABORATORY SPACE AND FACILITIES

Name of Laboratory ______________________________

		(1) Score	X	(2) Weight	=	(3) Extension
Question 1.	General Characteristics of Space and Facilities			1		
Question 2.	Office Space			1		
Question 3.	Laboratory Space*			2		
Question 4.	Bench-top Space			1		
Question 5.	Hood Space and Operation			1		
Question 6.	Storage Space - Chemicals			1		
Question 7.	Sample Storage Space*			2		
Question 8.	Controlled Space*			2		
Question 9.	Library			1		
Question 10.	Safety Equipment/Procedures*			2		
Question 11.	Distilled/Deionized Water*			2		
Question 12.	Glassware Supply and Washing*			2		
Question 13.	Housekeeping			1		
Question 14.	Data Processing Equipment and Logistic Services			1		______
	TOTAL					

Calculation:

$$\frac{\text{Total Col (3)}}{100} \times 10$$

Enter this figure in box below and carry it forward to Summary Evaluation.

Score carried forward to Summary Evaluation. ☐☐

*Any score of 1 in positions in Col (1) marked with an asterisk must be resolved before the final score is calculated.

Date ______________________ Visit Conducted by ______________________

PART 4. SCORE FOR ANALYTICAL METHODS

Name of Laboratory ______________________________

		(1) Score	X	(2) Weight	=	(3) Extension
Question 1.	Reference Methods or Approved Alternates*			1		
Question 2.	Reagent and Media Preparation			1		
Question 3.	Performance According to Standard			2		______
	TOTAL					

Calculation:

$$\frac{\text{Total Col (3)}}{20} \times 10$$

Score carried forward to Summary Evaluation. ☐☐

---

*Any score of 1 in positions in Col (1) marked with an asterisk must be resolved before the final score is calculated.

Date ______________________________ Visit Conducted by ______________________

PART 5. SCORE FOR INSTRUMENTS

Name of Laboratory ________________________________

		(1) Score	X	(2) Weight	=	(3) Extension
Question 1.	Required Instrumentation*			1		
Question 2.	Function Tests and Standardization of Instruments			2		
Question 3.	Calibration Equipment			1		
	TOTAL					

Calculation:

$$\frac{\text{Total Col (3)}}{20} \times 10$$

Score carried forward to Summary Evaluation. ☐☐

---

*Any score of 1 in positions in Col'(1) marked with an asterisk must be resolved before the final score is calculated.

Date ________________________ Visit Conducted by ________________________

PART 6. SCORE FOR INTERNAL AND EXTERNAL CONTROLS

Name of Laboratory ______________________________

		(1) Score	X	(2) Weight	=	(3) Extension
Question 1.	Responsibility for Calibration			1		
Question 2.	Adequacy of Calibration Logs			1		
Question 3.	Adequacy of Calibration and Maintenance Practices*			2		
Question 4.	Sampling Plans and Sampling Equipment			1		
Question 5.	Sample Collection and Preservation			2		
Question 6.	Identification and Storage of Samples *			1		
Question 7.	Laboratory Handling of Samples			1		
Question 8.	Chain of Custody*			2		
Question 9.	Field Control of Sampling			1		
Question 10.	Control of Monitoring Activities			1		
Question 11.	Clarity of QC Policy			1		
Question 12.	Written Program/Manual*			1		
Question 13.	Responsibility for Quality*			1		
Question 14.	Training in QC			1		
Question 15.	Control of Chemicals and Reagents			1		
Question 16.	Internal Checks: Precision and Accuracy			1		
Question 17.	Internal Checks: Routine Duplicates, Blanks, Spikes*			2		
Question 18.	Statistical Methods			1		
Question 19.	Inter-lab Proficiency Tests*			1		
Question 20.	Record System			1		
Question 21.	Report System			1		
	TOTAL					

Calculation:

$$\frac{\text{Total Col (3)}}{125} \times 30$$

Enter this figure in the box below and carry it forward to Summary Evaluation.

Score carried forward to Summary Evaluation. ☐☐

***Any score of 1 in positions in Col (1) marked with an asterisk must be resolved before the final score is calculated.**

Date ______________________ Visit Conducted by ______________________

SUMMARY OF LABORATORY EVALUATION

Name of Laboratory ______________________________

		Score
Part 1.	General Information	
Part 2.	Personnel	
Part 3.	Lab Space and Facilities	
Part 4.	Technical Services (Analytical Methods)	
Part 5.	Lab Equipment	
Part 6.	Internal and External Controls	
	TOTAL	

Inadequacies marked by * in the score sheets have not been resolved and above is a tentative score. ☐

Final Score ______________

Date ______________________ Evaluation Completed by ______________________

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APPENDIX

MAJOR EQUIPMENT REQUIREMENTS FOR EACH ANALYTICAL METHOD

General Analytical Methods

1. Alkalinity as $CaCO_3$ (mg $CaCO_3$/liter)

    (a) Electrometric Titration, Manual

    - pH meter, Type I or II as defined in ASTM D1293

    (b) Electrometric Titration, Automated

    - An automatic titrimeter meeting the pH meter specifications in (a).

    (c) Automated, Methyl Orange

    - Technicon AutoAnalyzer with

        (1) Sampler I
        (2) Continuous filter
        (3) Manifold
        (4) Proportioning pump
        (5) Colorimeter with 15 mm tubular flow cell and 550 nm filters
        (6) Recorder with range expander

2. Biochemical Oxygen Demand (B.O.D.) 5-day, 20°C (mg.liter)

    (a) Modified Wrinkler with Full-Bottle

    - B.O.D. incubation bottles

    (b) Probe Method

    - No specific probe is recommended as superior in the 1974 EPA Methods Manual, but ones evaluated and found reliable were Weston and Stack DO Analyzer Model 30, Yellow Springs Instrument (YSI) Model 54, and the Beckman Fieldlab Oxygen Analyzer.

3. Chemical Oxygen Demand (C.O.D.) (mg/liter)

   (a) No special equipment, other than standard laboratory glassware.

4. Total Solids (Total Residue) (mg/liter)

   (a) Gravimetric, dried at 103-105°C

   - Blender (if samples contain oil or grease)
   - Porcelain, vycor, or platinum evaporating dishes
   - Muffle furnace, 550°C
   - Steam bath or 98°C oven
   - Drying oven, 103-105°C
   - Dessicators
   - Analytical balance, 200 g capacity, weighing to 0.1 mg

5. Total Dissolved Solids (Total Filterable Residue) (mg/liter)

   (a) Glass fiber filtration, dried at 180°C

   - Glass fiber filter discs: Reeve Angel 934A, 984-H, Gelman type A, or equivalent
   - Filter holder, membrane filter funnel, or Gooch crucibles and adapter
   - Suction flask
   - Porcelain, vycor, or platinum evaporating dishes
   - Muffle furnace, 550°C
   - Steam bath
   - Drying oven, 180°C
   - Dessicators
   - Analytical balance, 200 g capacity, weighing to 0.1 mg

6. Total Suspended Solids (Total Non-Filterable Residue) (mg/liter)

   (a) Glass fiber filtration, dried at 103-105°C

   - Same as (5), except drying oven is at 103-105°C and steam bath, muffle furnace, and evaporating dishes are not required.

7. Total Volatile Solids (Volatile Residue) (mg/liter)

   (a) Gravimetric, dried at 550°C

   - Same as (5)

8. Ammonia (as N) (mg/liter)

   (a) Distillation and titration

   - All glass distillation apparatus (Kjeldahl)
   - Standard titration apparatus

   (b) Distillation and nesslerization

   - All-glass distillation apparatus (Kjeldahl)
   - Nessler tubes, 50 ml, matched set, APHA standard
   - Spectrophotometer or filter photometer for use at 425 nm with light path $\geq$ 1 cm.

   (c) Distillation and ammonia electrode

   - All-glass distillation apparatus (Kjeldahl)
   - Electrometer (pH meter) with expanded mV scale or specific ion meter
   - Ammonia selective electrode, such as Orion Model 95-10 or EIL Model 8002-2
   - Magnetic stirrer, thermally-insulated, and Teflon-coated stirring bar

   (d) Automated colorimetric phenate method

   - Technicon AutoAnalyzer (AAI or AAII) with

     (1) Sampler
     (2) Manifold (AAI) or Analytical Cartridge (AAII)
     (3) Proportioning pump
     (4) Heating bath with double delay coil (AAI)
     (5) Colorimeter with 15 mm tubular flow cell and 630-660 nm filters
     (6) Recorder
     (7) Digital printer for AAII (optional)

9. Total Kjeldahl Nitrogen (as N) (mg/liter)

(a) Digestion, distillation, and titration

- Same as 8(a) with suction takeoff to remove SO_3 fumes during digestion

(b) Digestion, distillation, and nesslerization

- Same as 8(b) with suction takeoff to remove SO_3 fumes during digestion

(c) Digestion, distillation, and ammonia electrode

- Same as 8(c) with suction takeoff to remove SO_3 fumes during digestion

(d) Automated phenate method

- Technicon AutoAnalyzer with

    (1) Sampler II with continuous mixer
    (2) Two proportioning pumps
    (3) Manifolds I and II
    (4) Continuous digester
    (5) Planetary pump
    (6) Five-gal. Carboy fume trap
    (7) Heating bath, 80°C
    (8) Colorimeter equipped with 50 mm tubular flow cell and 630 nm filters
    (9) Recorder with range expander
    (10) Vacuum pump

(e) Automated selenium method

- Technicon AutoAnalyzer with

    (1) Sampler
    (2) Two manifolds (as in EPA Manual)
    (3) Two proportioning pumps
    (4) Continuous digester
    (5) Two 5-gal. Carboys
    (6) Colorimeter with 15 or 50 mm flow cell and 630 or 650 nm filter
    (7) Recorder
    (8) Vacuum pump

10. Nitrate (as N) (mg/liter)

   (a) Cadmium Reduction Method (Nitrate - Nitrate)

   - Glass fiber or membrane filters and associated apparatus
   - Copper/cadmium reduction column
   - Spectrophotometer or filter photometer for use at 540 nm with light path $\geq$ 1 cm.

   (b) Automated Cadmium Reduction Method (Nitrate - Nitrate)

   - Glass fiber or membrane filters and associated apparatus
   - Copper/cadmium reduction column
   - Technicon AutoAnalyzer (AAI or AAII) with
     (1) Sampler
     (2) Manifold (AAI) or Analytical Cartridge (AAII)
     (3) Colorimeter with 15 or 50 mm tubular flow cell and 540 nm filters
     (4) Recorder
     (5) Digital printer for AAII (optional)

   (c) Brucine Method

   - Spectrophotometer or filter photometer for use at 410 nm
   - Water bath at 100°C (Temperature control is critical: all sample tubes must be held at the same temperature, and temperature must not drop significantly when tubes are immersed in bath.)
   - Water bath at 10-15°C
   - Neoprene-coated wire rack for holding sample tubes in baths
   - Glass sample tubes (40-50 ml)

11. Total Phosphorus (as P) (mg/liter)

   (a) Single Reagent (Ascorbic Acid Reduction Method)

   - Spectrophotometer or filter photometer for use at 650 nm (less sensitive) or 880 nm
   - Acid-washed, detergent-free glassware
   - Hotplate or autoclave (for persulfate digestion)

(b) Automated Colorimetric Ascorbic Acid Reduction Method

- Acid-washed, detergent-free glassware

- Hotplate or autoclave (for persulfate digestion)

- Technicon AutoAnalyzer with

  (1) Sampler
  (2) Manifold (AAI) or Analytical Cartridge (AAII)
  (3) Proportioning pump
  (4) Heating bath, 50°C
  (5) Colorimeter with 15 or 50 mm tubular flow cell and 650-660 or 880 nm filter
  (6) Recorder
  (7) Digital printer for AAII (optional)

12. Acidity (mg $CaCO_3$/liter)

(a) Hydrogen peroxide digestion and electrometric titration

- pH meter, Type I or II as defined in ASTM D1293

(b) Hydrogen peroxide digestion and phenolphthalein end-point titration

- No special equipment, other than standard laboratory glassware

13. Total Organic Carbon (T.O.C.) (mg/liter)

(a) Combustion and infrared method (CO_2) or flame ionization method (CH_4)

- Waring or other blender

- Apparatus for total and dissolved organic carbon (No specific model is recommended, but several have been found reliable: Dow-Beckman Carbonaceous Analyzer Model #915 (infrared), Dohrmann Envirotech DC-50 Carbon Analyzer (flame ionization), Oceanographic International Total Carbon Analyzer).

14. Total Hardness (mg $CaCO_3$/liter)

(a) EDTA titration

- No special equipment, other than standard laboratory glassware

(b) Automated colorimetric

Technicon AutoAnalyzer with

(1) Sampler I
(2) Continuous filter
(3) Manifold
(4) Proportioning pump
(5) Colorimeter equipped with 15 mm tubular flow cell and 520 nm filters
(6) Recorder with range expander

(c) Atomic absorption (Ca + Mg)

(See atomic absorption section below)

15. Nitrate (as N) (mg/liter)

(a) Manual colorimetric diazotization

Spectrophotometer for use at 540 nm with cells $\geq$ 1 cm.

Nessler tubes or volumetric flasks, 50 ml

(b) Automated colorimetric diazotization

Glass fiber or membrane filters and associated apparatus

Technicon AutoAnalyzer (AAI or AAII) with

(1) Sampler
(2) Manifold (AAI) or Analytical Cartridge (AAII)
(3) Colorimeter with 15 or 50 mm tubular flow cell and 540 nm filters
(4) Recorder
(5) Digital printer for AAII (optional)

Analytical Methods for Trace Metals: Atomic Absorption Methods

For each parameter listed, EPA specifies atomic absorption as at least one of the reference methods. The required equipment in each case will include (1) an atomic absorption spectrophotometer, (2) the hollow cathode (or electric discharge) lamp for each metal, and (3) the fuels and other apparatus specified below. Design features of some common atomic absorption spectrophotometers (as of June, 1972) are discussed in the EPA Handbook for Analytical Quality Control in Water and Wastewater Laboratories. If extraction procedures are to be used, special reagents are required but no special equipment other than standard laboratory glassware. Results are reported in mg/liter.

	Fuels				
Parameter	Acetylene	Air		Nitrous oxide	Other
Aluminum	X	X		X	
Antimony	X	X			
Arsenic (Gaseous Hydride)					Argon-hydrogen flame
Barium	X			X	
Beryllium	X			X	
Cadmium	X	X			
Calcium	X	X	or	X	Nitrous oxide more sensitive
Chromium VI	X	X	or	X	Nitrous oxide more sensitive; extraction with APDC required for separation of Cr VI from Cr III
Chromium, total	X	X	or	X	Nitrous oxide more sensitive
Cobalt	X	X			
Copper	X	X			
Iron	X	X			
Lead	X	X			
Magnesium	X	X			
Manganese	X	X			
Mercury (Cold Vapor)					Flameless atomic absorption: details below
Molybdenum	X			X	
Nickel	X	X			

Continued

Parameter	Fuels			
	Acetylene	Air	Nitrous oxide	Other
Potassium	X	X		Osram potassium vapor discharge lamp also may be used.
Selenium (Gaseous Hydride)				Argon-hydrogen lamp
Silver	X	X		
Sodium	X	X		
Thallium	X	X		
Tin	X	X		
Titanium	X		X	
Vanadium	X		X	
Zinc	X	X		

Other Reference Methods for Metals

16. Aluminum (mg/liter)

(a) Eriochrome cyanine R colorimetric method

- Spectrophotometer for use at 535 nm, or
- Filter photometer with 525-535 nm filters (green, or
- Nessler tubes, 50 ml

17. Arsenic (mg/liter)

(a) Gaseous Hydride - Silver Diethyldithiocarbamate Colorimetric Method

- Arsine generator and absorption tube
- Spectrophotometer for use at 535 nm, or
- Filter photometer with 530-540 nm filter (green)

18. Beryllium (mg/liter)

(a) Aluminon method

- Spectrophotometer or filter photometer for use at 515 nm with 5 cm cells

19. Boron (mg/liter)

(a) Curcumin method

- Spectrophotometer or filter photometer for use at 540 nm with cells ≥ 1 cm.
- Vycor or platinum evaporating dishes, 100-150 ml
- Water bath, 55 ± 2°C
- Ion exchange column, 50 cm x 1.3 cm (diameter)

20. Cadmiun (mg/liter)

(a) Dithizone Colorimetric Method

- Spectrophotometer or filter photometer for use at 515 nm

21. Calcium (mg/liter)

(a) EDTA Titration

- No special equipment

22. Chromium VI (mg/liter)

(a) Diphenylcarbazide colorimetric

- Membrane or sintered glass filter
- Spectrophotometer or filter photometer for use at 540 nm with cells ≥ 1 cm.

23. Chromium, total (mg/liter)

(a) Oxidation and diphenylcarbazide colorimetric

- Membrane or sintered glass filter.
- Spectrophotometer or filter photometer for use at 540 nm with cells ≥ 1 cm.

24. Copper (mg/liter)

    (a) Neocuproine colorimetric

    - Spectrophotometer for use at 457 nm with cells $\geq$ 1 cm, or
    - Filter photometer with narrow-band violet filter (max. transmittance at 450-460 nm) and cells $\geq$ 1 cm, or
    - Nessler tubes, 50 ml.

25. Iron (mg/liter)

    (a) o-Phenanthroline colorimetric

    - Spectrophotometer or filter photometer for use at 510 nm with cells $\geq$ 1 cm, or
    - Nessler tubes, 100 ml

26. Lead (mg/liter)

    (a) Dithizone colorimetric

    - Spectrophotometer or filter photometer for use at 520 nm with cells $\geq$ 1 cm
    - pH meter

27. Magnesium (mg/liter)

    (a) Gravimetric

    - No special equipment

28. Mercury (mg/liter)

    (a) Manual Cold Vapor Technique (Water or Sediment)

    - Commercially available mercury analyzer employing this technique, or
    - Atomic absorption spectrophotometer with open sample presentation area for mounting 10 cm absorption cell
    - Mercury hollow cathode lamp: Westinghouse WL-22847, argon-filled, or equivalent
    - Recorder: multi-range, variable speed, compatible with UV detection system

- Absorption cell, 10 cm, quartz end windows, vapor inlet and outlet ports
- Air pump, peristaltic, 1 liter/min.
- Flowmeter
- Aeration tubing and drying tube (or incandescent lamp to warm cell)
- Autoclave (optional, for digestion procedure)

(b) Automated Cold Vapor Technique

- Technicon AutoAnalyzer with
  (1) Sampler II with provision for sample mixing
  (2) Manifold
  (3) Proportioning Pump II or III
  (4) High temperature heating bath with two distillation coils in series
- Vapor-liquid separator
- Absorption cell, 10 cm, quartz end windows
- Atomic absorption spectrophotometer with open sample presentation area for mounting 10 cm cell (or commercially available analyzer employing this technique)
- Mercury hollow cathode lamp: Westinghouse WL-22847, argon-filled, or equivalent
- Recorder: multi-range, variable speed, compatible with UV detection system
- Cooling water for mixing coil and connector and heat lamp for absorption cell

29. Nickel (mg/liter)

(a) Heptoxime colorimetric method

- Spectrophotometer or filter photometer for use at 445 nm with cells $\geq$ 1 cm.

30. Potassium (mg/liter)

(a) Colorimetric

- Spectrophotometer for use at 425 nm with cells $\geq$ 1 cm, or

- Filter photometer with violet filter (max. transmittance near 425 nm) and ≥ 1 cm cells, or

- Nessler tubes, 100 ml

- Centrifuge and 25 ml. centrifuge tubes

(b) Flame photometric

- Flame photometer, direct-reading or internal-standard, and associated equipment for measurement at 768 nm

31. Sodium (mg/liter)

(a) Flame photometric

- Flame photometer, direct-reading or internal-standard, and associated equipment for measurement at 589 nm

- For low-solids water, air filter and blower for burner housing, oxyhydrogen flame, and polyethylene or Teflon cups, bottles, etc.

32. Vanadium (mg/liter)

(a) Colorimetric (Catalysis of gallic acid oxidation)

- Spectrophotometer or filter photometer for use at 415 nm with 1-5 cm cells

- Water bath, 25 ± 0.5°C

33. Zinc (mg/liter)

(a) Dithizone colorimetric method

- Spectrophotometer or filter photometer for use at 535 or 620 nm with 2 cm cells, or

- Nessler tubes, matched

- pH meter

Analytical Methods for Nutrients, Anions, and Organics

34. Organic Nitrogen (as N) (mg/liter)

(a) Kjeldahl Nitrogen minus Ammonia Nitrogen

- See (8) and (9) above.

35. Orthophosphate (as P) (mg/liter)

- See (11) above

36. Sulfate (as SO_4) (mg/liter)

(a) Gravimetric

- Analytical balance, weighing to 0.1 mg
- Steam bath
- Drying oven, 180°C
- Muffle furnace, 800°C
- Appropriate filters or crucibles

(b) Trubidimetric

- Nephelometer or
- Spectrophotometer or filer photometer for use at 420 nm with 4-5 cm cells
- Magnetic stirrer with timer or stopwatch

(c) Automated colorimetric barium chloroanilate

- Technicon AutoAnalyzer with

  (1) Sampler I
  (2) Continuous filter
  (3) Manifold
  (4) Proportioning pump
  (5) Colorimeter with 15 mm tubular flow cell and 520 nm filters
  (6) Recorder
  (7) Heating bath, 45°C

- Magnetic stirrer

37. Sulfide (as S) (mg/liter)

(a) Titrimetric iodine

- No special equipment, other than standard laboratory glassware.

38. Sulfite (as SO_3) (mg/liter)

(a) Titrimetric iodide-iodate

- No special equipment, other than standard laboratory glassware

39. Bromide (mg/liter)

(a) Titrimetric iodide-iodate

- No special equipment, other than standard laboratory glassware

40. Chloride (mg/liter)

(a) Silver nitrate

- No special equipment, other than standard laboratory glassware

(b) Mercuric nitrate

- No special equipment, other than standard laboratory glassware

(c) Automated colorimetric ferricyanide

- Technicon AutoAnalyzer with

(1) Sampler I
(2) Continuous filter
(3) Manifold
(4) Proportioning pump
(5) Colorimeter with 15 mm tubular flow cell and 480 nm filters
(6) Recorder

41. Cyanide, total (mg/liter)

(a) Distillation and silver nitrate titration

- Cyanide distillation apparatus

- Koch microburet, 5 ml.

(b) Distillation and pyridine-pyrazolone (or pyridine-barbituric acid) colorimetric

- Cyanide distillation apparatus

- Spectrophotometer or filter photometer for use at 578 or 620 nm with $\geq$ 1 cm cells.

42. Fluoride (mg/liter)

    (a) Distillation - SPADNS

    - Simple Bellack distillation apparatus
    - Spectrophotometer for use at 570 nm with $\geq$ 1 cm cells, or
    - Filter photometer with green-yellow filter (max. transmittance 550-580 nm) and $\geq$ 1 cm cells

    (b) Automated complexone method

    - Technicon AutoAnalyzer with
        (1) Sampler I
        (2) Manifold
        (3) Proportioning pump
        (4) Continuous filter
        (5) Colorimeter with 15 mm tubular flow cell and 650 nm filters
        (6) Recorder with range expander

    (c) Fluoride electrode

    - Electrometer
    - Fluoride ion activity electrode
    - Reference electrode, single junction, sleeve-type
    - Magnetic mixer

43. Chlorine, total residual (mg/liter)

    (a) Starch-iodide titration

    - No special equipment, other than standard laboratory glassware

    (b) Amperometric titration

    - Amperometric end-point detection apparatus, consisting of noble metal electrode, salt bridge, and silver - silver chloride reference electrode cell unit connected to microammeter with appropriate electrical accessories.
    - Agitator

44. Oil and Grease (mg/liter)

(a) Gravimetric

- Separatory funnels or soxhlet apparatus
- Vaccuum

(b) Infrared

- Spearatory funnels
- Infrared spectrophotometer, double beam, with 1, 5, and 10 cm cells

45. Phenols (mg/liter)

(a) Colorimetric (4-AAP method with distillation)

- Phenols distillation apparatus
- Spectrophotometer or filter photometer for use at 460 nm (following chloroform extraction) or 510 nm and 1-10 cm cells
- pH meter

(b) Automated 4-AAP method

- Technicon AutoAnalyzer (I or II) with

  (1) Sampler
  (2) Manifold
  (3) Proportioning pump II or III
  (4) Heating bath with distillation coil
  (5) Distillation head
  (6) Colorimeter with 50 mm flow cell and 505 or 520 nm filter
  (7) Recorder

46. Surfactants (mg/liter)

(a) Methylene blue colorimetric

- Spectrophotometer or filter photometer for use at 625 nm with $\geq$ 1 cm cells

47. Algicides (mg/liter)

(a) Gas chromatography

- There is no reference procedure for algicides as a class, and, therefore, detailed equipment requirements cannot be specified. For general discussion of gas chromatography and its application in environmental monitoring, see the EPA Training Manual for Pesticide Residue Analysis in Water and the EPA Methods Manual for Analysis of Pesticide Residues in Human and Environmental Samples.

48. Benzidine (mg/liter)

(a) Diazotization and colorimetric

- Spectrophotometer, scanning, 510-370 nm
- Cells, 1-5 cm pathlength, 20 ml max. volume

49. Chlorinated organic compounds (except pesticides) (mg/liter)

(a) Gas chromatography

- There is no reference procedure for chlorinated organic com compounds as a class, and, therefore, detailed equipment requirements cannot be specified. Gas chromatography with electron capture, microcoulometry, or electrolytic conductivity detection may be appropriate for individual compounds or groups of compounds. For general discussions of gas chromatography and its application in environmental monitoring, see the EPA Training Manual for Pesticide Residue Analysis in Water and the EPA Methods Manual for Analysis of Pesticide Residues in Human and Environmental Samples.

50. Pesticides (μg/liter)

- There is no single reference procedure for pesticides as a class. However, specific reference procedures for several sub-classes are available from EMSL, USEPA, Cincinnati, Ohio. To be qualified in this parameter, the laboratory should be equipped to analyze for all specified sub-classes. The analysis of pesticides at the levels normally found in wastewater and other environmental sources requires special expertise and experience, in addition to up-to-date, well-maintained, calibrated instrumentation and apparatus. The equipment lists below are based on the EMSL methods; for further information on the equipment and methodology of pesticide analysis, see the EPA Training Manual for Pesticide Residue Analyses in Water and the EPA Methods Manual for Analysis of Pesticide Residues in Human and Environmental Samples.

(a) Organochlorine pesticides

- Gas chromatograph with

  (1) Glass-lined injection port
  (2) One or more of the following detectors:
  Electron capture, radioactive (H^3 or Ni^{63})
  Microcoulometric titration
  Electrolytic conductivity
  (3) Recorder, potentiometric, 10" strip chart
  (4) Appropriate Pyrex gas chromatographic columns

- Snyder columns, 3-ball (macro) and 2-ball (micro), and other K-D glassware

- Appropriate columns for liquid-solid partition chromatography

- Blender

- Special materials, such as PR Grade Florisil and pesticide standards

(b) Organophosphorus pesticides

- Gas chromatograph with

  (1) Glass-lined injection port
  (2) One or more of the following detectors:
  Flame photometric, 526 nm phosphorus filter
  Electron capture, radioactive (H^3 or Ni^{63})
  (3) Recorder, potentiometric, 10" strip chart
  (4) Appropriate Pyrex gas chromatographic columns

- Snyder columns, 3-ball (macro) and 2-ball (micro), and other K-D glassware

- Appropriate columns for liquid-solid partition chromatography

- Blender

- Special materials, such as PR Grand Florisil, Woelm neutral alumina, and pesticide standards

(c) Polychlorinated biphenyls (PCB's)

- Gas chromatograph with

  (1) Glass-lined injection part

  (2) One or more of the following detectors:

Electron capture, radioactive (H^3 or Ni^{63})
Microcoulometric titration
Electrolytic conductivity

(3) Recorder, potentiometric, 10" strip chart
(4) Appropriate Pyrex gas chromatographic columns

- Snyder column, 3-ball (macro)
- Appropriate columns for liquid-solid partition chromatography
- Low-pressure regulator (0-5 psig) with low-flow needle valve
- Blender
- Special materials, such as PR Grade Florisil, high-quality silica gel, and Aroclor (PCB) standards

(d) Triazine pesticides

- Gas chromatograph with

(1) Glass-lined injection part
(2) Electrolytic conductivity detector
(3) Recorder, potentiometric, 10" strip chart
(4) Appropriate Pyrex gas chromatographic column

- Snyder columns, 3-ball (macro) and 2-ball (micro), and other K-D glassware
- Appropriate columns for liquid-solid partition chromatography
- Blender
- Special materials, such as PR Grade Florisil and pesticide standards

(e) O-Aryl carbamate pesticides

- Thin layer chromatography plates, 200 x 200 mm, coated with Silica Gel G, 0.25 mm
- Associated TLC apparatus, including spotting template, developing chamber, and sprayer (20 ml)

51. Specific Conductance (mho/cm @ 25°C)

(a) Wheatstone bridge

- Commercial conductivity meter, or
- Apparatus consisting of
  - (1) Wheatstone bridge (reading to 1% accuracy or better)
  - (2) Appropriate source of electrical current
  - (3) Specific conductance cell
  - (4) Water bath, 25°C, with racks

52. Turbidity (Jackson units)

(a) Turbidimeter method

- Nephelometric turbidimeter, such as Hach Model 2100 or 2100A or equivalent

53. Streptococci bacteria, fecal (number/100 ml)

(a) MPN

- Autoclave (to 121°C)
- Inoculation tubes
- Incubator, 35 ± 0.5°C

(b) Membrane filter

- Autoclave (to 121°C)
- Filter membranes
- Petri culture dishes
- Incubator, 35 ± 0.5°C, ca. 90% relative humidity
- Low-power (10-15X), binocular, wide-field, dissecting microscope and light source

(c) Plate count

- Autoclave (to 121°C)
- Petri culture dishes
- Incubator, 35 ± 0.5°C

- Microscope and light source, or

- Colony counter

54. Specific Conductance (mho/cm @ 25°C)

    (a) Wheatstone bridge

    - Commercial conductivity meter, or

    - Apparatus consisting of

      (1) Wheatstone bridge (reading to 1% accuracy or better)
      (2) Appropriate source of electrical current
      (3) Specific conductance cell
      (4) Water bath, 25°C, with racks

55. Turbidity (Jackson units)

    (a) Turbidimeter method

    - Nephelometric turbidimeter, such as Hach Model 2100 or 2100A or equivalent

56. Streptococci bacteria, fecal (number/100 ml)

    (a) MPN

    - Autoclave (to 121°C)

    - Inoculation tubes

    - Incubator, 35 ± 0.5°C

    (b) Membrane filter

    - Autoclave (to 121°C)

    - Filter membranes

    - Petri culture dishes

    - Incubator, 35 ± 0.5°C, ca. 90% relative humidity

    - Low-power (10-15X), binocular, wide-field, dissecting microscope and light source

    (c) Plate count

    - Autoclave (to 121°C)

- Petri culture dishes
- Incubator, 35 ± 0.5°C
- Microscope and light source, or
- Colony counter

57. Coliform bacteria, fecal (number/100 ml)

    (a) MPN

    - Autoclave (to 121°C)
    - Inoculation tubes
    - Incubator, 35 ± 0.5°C
    - Water bath, 44.5 ± 0.2°C

    (b) Membrane filter

    - Autoclave (to 121°C)
    - Filter membranes
    - Petri culture dishes
    - Water bath, 44.5 ± 0.2°C
    - Low-power (10-15X), binocular, wide-field, dissecting microscope and light source

58. Coliform bacteria, total (number/100 ml)

    (a) MPN

    - Same as 56 (a)

    (b) Membrane filter

    - Same as 56 (b)

Radiological Parameters:

The analysis of radiological parameters requires special expertise and experience, in addition to up-to-date, well-maintained, calibrated instrumentation and apparatus.

59. Alpha, total (pCi/liter)

- Windowless Gas-Flow Proportional Counter and associated equipment, or
- Thin Window Gas-Flow Proportional Counter and associated Equipment, or
- Alpha Scintillation Counter and associated equipment, or
- Alpha Spectrometer (Surface Barrier Type) System and associated equipment

60. Alpha counting error (pCi/liter)

- Same as 59.

61. Beta, total (pCi/liter)

- Windowless Gas-Flow Proportional Counter and associated equipment, or
- Thin Window Gas-Flow Proportional Counter and associated equipment, or
- Beta Scintillation Counter and associated equipment, or
- Liquid Scintillation Counter and associated equipment

62. Beta counting error (pCi/liter)

- Same as 61.

63. Radium, total (pCi/liter)

- Windowless Gas-Flow Proportional Counter and associated equipment, or
- Thin Window Gas-Flow Proportional Counter and associated equipment, or
- Alpha Scintillation Counter and associated equipment, or
- Alpha Spectrometer (Surface Barrier Type) System and associated equipment, or
- Radon Gas Counting System and associated equipment

Other Parameters

64. Temperature

- Good quality mercury-filled or dial type centigrade thermometer, or a thermistor

65. pH

- pH meter (electrometer using either glass electrode and reference, such as saturated calomel, or a combination glass and reference electrode)

Air Parameters

66. Sulfur Dioxide (μg/m^3 or ppm)

(a) Pararosamiline Method

- Absorber
- Pump
- Air flowmeter or critical orifice
- Spectrophotometer for use at 548 nm, band width < 15 nm, with 1 cm cells

67. Suspended Particulates (μg/m^3)

(a) High-Volume Method

- High-volume Sampler
- Shelter for Sampler
- Flow measurement equipment, including:
  (1) Rotameter
  (2) Orifice Calibration Unit
  (3) Differential manometer
  (4) Positive Displacement Meter
- Barometer
- Environment for conditioning filters
- Analytical balance: chamber to hold unfolded 8" x 10" filters, sensitivity = 0.1 mg

- Glass fiber filters
- Acceptable alternative equipment for flow measurement (3-6): Exhaust orifice meter, interfaced with a circular chart recorder.

68. Carbon monoxide ($\mu g/m^3$ or ppm)

(a) Non-dispersive Infrared Spectrometry

- Carbon monoxide analyzer (for example, Intech NDIR-CO Analyzer)
- Pump, flow control value, and flowmeter
- In-line filter for particles (2-10 μm)
- Moisture control (refrigeration unit, or drying tube)

69. Photochemical Oxidant (O_3) ($\mu g/m^3$ or ppm)

(a) Chemiluminescence, continuous

- Commercial photochemical oxidant (O_3) analyzer, or
- Apparatus consisting of:

  (1) Detector cell
  (2) Flowmeters (air and ethylene)
  (3) Air Inlet Filter (Teflon, 5 m)
  (4) Photomultiplier tube
  (5) High Voltage Power Supply
  (6) Direct Current Amplifier
  (7) Recorder
  (8) Ozone Source (low pressure Hg lamp/quartz tube) and Dilution System

- Apparatus for Calibration ($KI \longrightarrow I_2$ spectrophotometric method)

70. Total Hydrocarbons (corrected for methane) GC - FID

(a) Method

- Commercially Available THC, CH_4, and CO Analyzer
- Pump, flow control valves, automatic switching valves, and flowmeter
- In-line filter (3-5 μm)

- **Stripper or Precolumn**

- **Oven (for column and catalytic converter)**

71. Nitrogen Dioxide ($\mu g/m^3$ or ppm)

(a) Arsenite 24-Hour Sampling Method

- **Sampling train (Bubbler, trap, membrane filter, 27-gauge hypodermic needle, air pump, calibration equipment)**

- **Standard glassware (volumetrics, pipets, graduated cylinders, etc.)**

- **Spectrophotometer or colorimeter for use at 540 nm.**

(b) Continuous Chemiluminescent Method

- **Commercial Chemiluminescent Analyzer: generally including particulate filter, thermal converter (NO_2 ——— NO), ozone generator, reaction chamber, optical filter, photomultiplier tube, and vacuum pump.**

- **Calibration apparatus (gas-phase titration method): generally including air flow controller, air flowmeters, pressure regulator for NO cylinder, NO flowmeters, capillary restriction, ozone generator, reaction chamber and mixing bulb, sample manifold, NO detector, iodometric calibration apparatus.**

(c) Griess-Saltzman Colorimetric, Continuous

- **Sampling train**

- **Colorimeter for use at 550 nm**